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ABSTRACT

This report focuses on the problem of cost allocation from the standpoint of an institution of higher education. Reliance has been almost entirely upon existing published and unpublished studies. The first 3 chapters provide background information and rely extensively on documentation to present broad coverage of views evident in the literature. The remaining chapters deal specifically with conceptual and methodological aspects of cost allocation at institutions of higher education. (Author)

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ELEMENTS RELATED TO THE DETERMINATION OF COSTS AND BENEFITS OF GRADUATE EDUCATION

By

John H. Powel, Jr., and Robert D. Lamson

THE COUNCIL OF GRADUATE SCHOOLS IN THE UNITED STATES

THE NATIONAL ASSOCIATION OF COLLEGE AND UNIVERSITY BUSINESS OFFICERS

Funded in Part by the National Science Foundation, Grant No. GR 80, Awarded to the Council of Graduate Schools
April 30, 1970

The Council of Graduate Schools / Washington, D.C. / March 1972

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FOREWORD

This study and analysis of the literature relative to the costs and benefits of graduate education (the GRADCOST study) was begun as a result of a resolution passed in December, 1968 at the Annual Meeting of the Council of Graduate Schools in the United States (CGS). Shortly thereafter, discussions were undertaken with representatives of the National Association of College and University Business Officers (NACUBO) and it was agreed to proceed with a study under joint sponsorship. This paper sets forth part of the results arising from this study.

A Joint Gradcost Committee was appointed by the officers of CGS and NACUBO, which also included representatives of the National Academy of Sciences and the Western Interstate Commission on Higher Education. Meetings were held in May, July, October and December of 1969 at which the Joint Committee concluded that a study and an analysis of the literature should be carried out as the first step toward securing the information needed in the field. On April 30, 1970, the National Science Foundation granted $78,000 to the CGS to assist in paying the costs of the study.

The study itself has been carried out by the Gradcost Research Group, which has worked in Seattle under a subcontract between the CGS and the University of Washington. Personnel were: Dr. Joseph L. McCarthy (Director), Mr. James F. Ryan, (Co-Director), Dr. Robert D. Lamson (Project Coordinator), Mr. John H. Powel, Jr. (Research Analyst).

The collection of the literature and the development of concepts for the analysis and reporting of results were performed by Dr. Robert D. Lamson and Mr. John H. Powel, Jr. The results of their analysis are presented in two parts:

Elements Related to the Determination of the Costs and Benefits of Graduate Education by John H. Powel, Jr. and Robert D. Lamson.

An Annotated Bibliography of Literature Relating to the Costs and Benefits of Graduate Education by John H. Powel, Jr. and Robert D. Lamson.

Major credit belongs to Mr. Powel for organizing and reviewing most of the massive body of literature covered, and especially for developing the conceptual framework used to analyze cost studies. The authors also assumed responsibility for coordination of this effort with the Cost Finding Principles Project now underway at the National Center for Higher Education Management Systems at the Western Interstate Commission for Higher Education. The contributions of these authors are greatly appreciated.

While the publication of these two papers concludes the joint effort of the CGS and NACUBO, it is clear that the existing literature leaves some of the most important questions which prompted the study unresolved. Among the problems unanswered are:

1. Adequate identification of the outputs and benefits of graduate education.
2. Agreement on how separately budgeted research and financial aid should be treated in determining the costs of graduate education.
3. Lack of a definitive and generally accepted set of procedures for allocating indirect costs to the outputs of graduate education.
4. Lack of comparable data on a broad basis as to the actual costs of graduate education.

These unanswered questions and unresolved issues lie at the heart of the problems besetting graduate education and should be the subject of continuing research, even though definitive answers and solutions may not be in the immediate offing.

It should be pointed out that the National Center for Higher Education Management Systems at WICHE is presently conducting empirical research on many of the unanswered questions listed above through projects dealing with cost finding principles, models for interinstitutional exchange of information, and measurement of the outputs of higher education.

As a more immediate commentary, Deans Joseph L. McCarthy and David R. Deener have authored a position paper which presents an alternative view of some of the issues raised in the literature and includes their recommendations on some key points. Their efforts are presented in a separate report sponsored by the CGS alone:

The Costs and Benefits of Graduate Education: A Commentary with Recommendations by Joseph L. McCarthy and David R. Deener.

It is recognized that this paper may not represent the views of some segements of the higher education community. In particular, it should be noted that the National Association for College and University Business Officers is not associated with this effort.

The Joint Gradcost Committee (listed below) has given substantial help to the Gradcost Study by providing general guidance and by reviewing drafts of the papers and reports. The contributions of the Joint Committee, and particularly the Steering Committee, are deeply appreciated, although they cannot be held responsible for the specific contents of the papers resulting from the study.

JOINT GRADCOST COMMITTEE

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University of Missouri (now University of Wisconsin)

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University of Cincinnati

Close communication has been maintained with representatives of the National Science Foundation and the advice and aid provided by Justin C. Lewis and Felix H. I. Lindsay, Study Director and Associate Study Director, respectively, of the Science Education Studies Group, and also Charles Falk, the Planning Director, have been very helpful.

Finally, appreciation is expressed to the graduate deans, financial affairs officers, faculty, students and public officials of the nearly 400 institutions and organizations who gave help and advice, and especially to the members of the Executive Committee of the CGS and the NACUBO for their continuing encouragement and support.

We hope and expect that the results of this study will be found useful by officers, faculty and students of colleges and universities in the United States, by representatives of government agencies, foundations, private donors, and indeed, citizens who are concerned with graduate education.

The Joint CGS-NACUBO Steering Committee

Kenneth D. Creighton
Paul V. Cusick
David R. Deener
Joseph L. McCarthy
J. Boyd Page
James F. Ryan

March, 1972

ACKNOWLEDGMENT BY THE AUTHORS

The authors wish to express their gratitude to the full GRADCOST Committee and the Steering Committee upon whose initiative this study developed, and whose active support, supervision, and discussions were invaluable throughout the course of the research. We would especially like to thank the directors of the project, Dr. Joseph L. McCarthy and Mr. James F. Ryan, for their careful attention and constructive criticisms which guided us during the project.

In addition, the authors wish to acknowledge the following contributions: During the course of the study through several lengthy discussions and reviews many helpful comments were received from Mr. Michael E. Young and Mr. Gordon Ziemer of the National Center for Higher Education Management Systems at the Western Interstate Commission for Higher Education. Editing of penultimate drafts, including the tracking down of countless fugitive sources and incomplete references, was performed by Dr. Barbara Howard. Also, gratitude is due Ms. Valerie Nelson whose diligent efforts in maintaining the extensive files of literature, working papers, and correspondence and whose conscientious respect for deadlines in the preparation of and distribution of working papers and chapter drafts to the committee were vital to the successful completion of the project.

Finally, the authors are indebted to the several individuals in various administrative and academic capacities at institutions throughout the country who took the time to review and comment on various drafts of these documents.

Robert D. Lamson
John H. Powel, Jr.

Seattle, Washington
September, 1971

INTRODUCTION[1]

> . . . There is a major need for accepted procedures and illustrative information concerning allocation of college and university costs on a basis of outputs or benefits arising from the activities of the institution. . . . More specifically, it appears that information on the total costs and also the total benefits of graduate education will be found useful by colleges and universities, as an aid to establishing priorities among continuing and/or new graduate and related programs . . . and by units of government . . . as an aid to rationalizing institutional allowances associated with fellowship and traineeship awards; as an aid in planning for allocations to colleges and universities . . . and as an aid in planning the nature and scale of capital facilities, which may be needed with expansion of graduate and professional educational activities in selected fields. (From: "A Proposal to the National Science Foundation From the Council of Graduate Schools in the United States Requesting Funding For a Study of the Costs of Graduate Education," January 21, 1971, p. 1.)

This statement from the GRADCOST Proposal clearly expresses the need for information which will facilitate the allocation of scarce resources to competing needs in higher education. Within the institution of higher education there is a need for the formation of some rational and consistent basis for resource allocation. Outside of the institution there is a need for a basis upon which supporters of graduate education can determine the level and mix of funding which best suit their objectives.

These information needs are made more urgent by the current crisis in funding which faces graduate education. While clients, on the one hand, are demanding more and better services, public and private funders, on the other, seem to be less willing or able to make financial support available.[2]

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[1]Numbers in brackets after author's name refer to number assigned to that item in the Bibliography.

[2]Generally speaking, this report approaches the problem of information needs in the context of competition for funds among institutions of higher education and effective use of these funds within the institution.

As a result, decision makers in higher education face the prospect of meeting increased demands with relatively diminishing resources.

Information which will best enable decision makers to cope with this new situation is that information which allows them to identify and evaluate the outputs of higher education, as well as to determine how much they cost. In order to support given levels of output, resource requirements for generating those levels must be known. In order to compete with other potential users for scarce resources, expenditures must be justified on the basis of benefits to be gained.[3] In other words, information is needed which relates to the role of higher education, including, of course, graduate education, as an economic process.

The context within which information needs should be discussed, then, is the problem of deciding "how to allocate scarce resources efficiently among the ever-increasing number of competitive activities or goals."[4]

A condition for efficient resource allocation is that the rate return on the funds invested be equal to the rate of return on funds in the best available alternative investment, public or private. This applies to investment in education, as well as any other form of public service or

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[3]A few of the many sources which have made this point are: Alden [5], Berls [28], Bowen [37], Breneman and Weathersby [48], Brown [50], Butter [53], Cartter [63], Firmin, et. al. [108], Fouraker [115], and many others.

[4]Hirsch [148], p. 2. See also the following sources: Danière [86], Firmin, et. al., op. cit., and Kettler [178].

With particular reference to graduate education, this same view has been expressed since the 1950s. For example, see Weaver [329], p. 44:

> . . . I believe that the problem which strikes me as having the broadest and most significant implications among all of the matters affecting graduate education has to do with the scope of our institutional resources and the wise and efficient use of them.

good. According to one author:

> . . . to proceed rationally, we must obviously regard all advantages of a policy as a return, and all disadvantages as a cost. . . . We have too many cost studies and not enough cost-benefit studies.[5]

In other words, it is not simply enough to know the value of inputs required for production of a given level and mix of outputs. The crucial question is whether the value of outputs produced justifies the expense required.

Cost Allocation Under Ideal Conditions

In this context, the role and scope of cost allocation becomes more clear. In order to understand this role, it is worthwhile to begin the discussion in ideal terms. In an ideal decision-making framework all outputs or benefits of university activity would be easily and separately identified and quantified, and each could be weighted with a definite price reflecting its true value to society. Furthermore, the process by which inputs generate outputs (the production process) would be known and easily expressed. Under these circumstances, we could "resolve conflicts by analyzing the expected monetary return of alternative resource allocations."[6] In particular, a set of rules for both the level and mix of funding and resource allocation would follow from the directive, enforced by appropriate incentive structures, that institutions of higher learning make the greatest possible net contribution to society. This goal could, in fact, be achieved with certainty by investing in each dimension of higher education, including graduate education, to the point where increments in outputs are worth no more than the increment in cost to produce them. Similarly, output mix would be such that the value of resources required to product increments to any group of outputs would be in proportion to the values of those outputs.[7]

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[5] Hamelman [133], p. 8, summarized the tasks facing the decision makers as follows:

> The central problems of the higher education decision making are: How much of what kinds of education for who [sic] and at whose cost and where?

[6] Knorr [182[, p. 12.

[7] Weathersby [327], p. 3.

Under conditions just described, effective resource allocation in higher education would be automatic. Cost information, which would be easily accessible to decision makers, would serve the following two purposes:

1. Information on costs of increments in outputs, together with information on the value of those additional outputs, would serve in making decisions on the level and mix of outputs produced.
2. Information on the cost of producing outputs at a point in time could be used for the dual purpose of control and determining social profitability.

It should be noted that different types of cost information are appropriate to each of these two purposes. Cost information which is appropriate for the first purpose, resource allocation decisions, must indicate how input requirements will vary with outputs. In other words, it must describe cost behavior over a range of outputs in order to guide *ex ante* decisions concerning the most desirable level and mix within that range. Information which is appropriate for the second type of purpose requires an *ex post* scrutiny of costs involved in the level and mix of output actually produced at a point in time. The latter information indicates both whether funds are being used as intended and whether the level and mix of outputs chosen is socially profitable at current prices.

Put another way, the difference between these two types of information is the following: The first type of cost information describes the change in total cost which will result in going from one level and mix of output to another. This type of information has been defined as "incremental," or more commonly, "marginal" costs. The second type of information describes the total cost of producing a single level and mix of output. Information concerning the total cost of producing a given number of outputs can also be expressed as "unit" or average cost information: the total cost divided by the number of outputs.[8]

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[8]For simple diagramatics of the conceptual problem of universities' choice of level and mix of outputs, see Black [31].

Obviously, the ideal world does not exist for decision makers in education, at any level. Outputs--the results of the educational process--are not easily standardized, separated, or quantified. In fact, it may be that the value of some outputs rests in their uniqueness to the institution producing them. Furthermore, there is no mechanism analogous to that of the marketplace to determine the value of increments of output.

Resource Allocation in Higher Education

Higher education in the United States is a system where outputs are in part socially financed and managerial directive replaces the price system in the allocation of resources, which in this case is not the result of competition among the individual economic units. The interest of clients served by higher education becomes the trust of the manager who acts in their stead to decide what level and mix of outputs to produce and how to produce them.[9]

The manager actually consists of a network of decision makers. This managerial chain begins with federal and state legislators in the case of public institutions, and with the alumni and other private funders in the case of private institutions. It leads from this level down to the chairmen of individual academic departments at the institution itself. To ensure the efficient allocation of funds, these various trustees must be aware of all benefits and all costs associated with the activities which they supervise. Not only must they conduct the more common-place business of resource allocation within the framework of legal and other constraints; they must also be able to assess and aggregate the heterogeneous interests and philosophies of their many constituencies in determining the relative merits of alternative educational objectives. Obviously, these considerations make extremely difficult demands on judgment and imagination.

An additional problem is that even on a conceptual level there is no firm agreement among scholars as to the specific operational conditions which may be identified with the level and mix of higher education outputs

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[9]Firmin, _et_. _al_. [108] and H.E.W. [308]. See also any textbook on price theory, such as: Baumo [24], Samuelson [258], and Stigler [282].

as making the greatest possible net contribution to society. Theoretical discussions of conditions which must apply for maximum effectiveness of resource use in higher education do appear in the literature. However, most authors question--even in theory--the possibility of determining a single level and mix of resource allocation which can be considered to maximize the effectiveness of resource use in higher education.[10]

The lack of such information leaves both administrators and funders of higher education facing uncertainties as to the value of outputs for which they are committing resources. In addition, because the lack of a well-defined production process stands in the way of developing universally accepted cost allocation procedures, it is difficult to determine precisely what resource commitments are currently being made for particular outputs or benefits, however specified. Lack of such measures may, in fact, have led to the use of effort, load, or other input-oriented measures as proxies for outputs.

Purpose of the GRADCOST Study

The present study has aimed at searching the pertinent literature in order to present in one volume a report on the state of development in areas of cost and benefit information. The present analytical volume has attempted to identify the benefits of graduate education and to analyze "accepted procedures and illustrative information concerning allocation of college and university costs." Furthermore, the study, in conjunction with related efforts such as the Western Interstate Commission for Higher Education (WICHE) Cost Finding Principles Study, takes a step towards standardizing cost allocation procedures and cost information.

This report focuses on, but is not limited to, the problem of cost allocation from the standpoint of an institution of higher education. Reliance has been almost entirely upon existing published and unpublished studies. No attempt has been made here to build econometric or statistical

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[10]Stubblebine [283], p. 15, for example, indicated that:
. . . the absence of a fully-developed theory of externalities precludes an attempt to define optimal levels, as does the inchoate nature of the data on the magnitude of externality relations and of the education-economic growth relation at the relevant margins of decision-making.

models for the analysis of unstructured data. The first three chapters provide background information and rely extensively on documentation to present broad coverage of views evident in the literature. The remaining chapters deal specifically with conceptual and methodological aspects of cost allocation at institutions of higher education.

It is not possible to discuss graduate education in complete isolation from higher education generally. Funders, clients, and decision makers for graduate education are in most cases the same as those for undergraduate education. While this report does attempt to isolate problems which are unique to graduate education, much of the material covered is applicable to higher education as a whole.

Outline of Chapters

Chapter 1 discusses the central problem of resource allocation in graduate education. In that context it discusses the importance of cost information and, in particular, cost allocation. The chapter contains a brief historical description of resource allocation in graduate education, as well as the role of cost studies in this context. It is pointed out in this chapter that a chronic problem in higher education costing is the determination of outputs to which costs are to be allocated.

Chapter 2 focuses on outputs. The currently-accepted measures of benefits and outputs of graduate education activities are summarized from a conceptual point of view. In addition, studies which deal with benefit measurement are classified.

Chapter 3 deals with concepts of cost information in the context of higher education. Several types of cost studies are described and illustrated.

Chapter 4 contains discussions of three important problems which arise in costing higher education outputs. First, the problem of activity definitions is discussed. Second, the problem of measuring academic manpower use is dealt with. Finally, the chapter addresses the problem of determining opportunity costs of capital services.

Chapter 5 deals with the problem of measuring or approximating individual program outputs in an institution of higher education for purposes of distributing their costs to activities which they support.

In Chapter 6, one of the most common types of cost study, the unit cost study based on program budget analysis, is discussed in detail. In this chapter, three commonly-used procedures and one potential procedure for the allocation of indirect costs to outputs of an institution of higher education are reviewed.

Chapter 7 takes up the question of allocating research costs to instructional outputs in the context of unit cost studies. Four alternatives for determining a share of allocable research costs are described.

Chapter 8 is a brief summary of the existing data on the costs of graduate education. It includes a characterization of the distribution of costs by level and discipline in graduate education.

CHAPTER 1

COST ALLOCATION: THE HISTORICAL PERSPECTIVE

Introduction

A review of the historical role played by cost information in higher education suggests areas in which conceptual advances with operational potential could be applied. Three such possibilities are:

1. Discontinuing the acceptance of cost as a substitute for output value in higher education decision making.
2. Developing and using, where appropriate, information on the manner in which costs and benefits vary over a range of outputs.
3. Developing and testing hypothetical theories of decision-making behavior in higher education in order to suggest incentive structures more consistent with the goals of clients and funders of higher education.

This chapter illustrates information needs related to these areas with reference to historical literature concerning the financing of higher education. While the third area mentioned is beyond the scope of the study, references are provided at the end of the chapter which do investigate current possibilities.

The chapter proceeds as follows: The first section contains a historical review of higher education costing and its role in the budgetary process; the second section discusses the influence of federal participation on the financing and planning of higher education; the third section summarizes newly developed planning techniques and describes problems in application of these new techniques; and the fourth section summarizes briefly the alternatives for educational finance which are currently posed in the literature.

The History and Evolution of Costing in Higher Education

The purposes, methods, and concepts of cost allocation in higher education have been the subject of countless institutional reports, governmental task force investigations, and individual monographs since the 1890s.[1] It is certain, in other words, that the "state of the art" as it exists today did not come into being as the result of one coordinated and well-defined effort. Current principles of cost allocation in higher education are the result of at least seventy-five years of endeavor by academic and professional people.

It is only in recent years, for example, that the concept of marginal costs has been given much currency in studies and reports on higher education cost allocation. The concept which guided cost studies through the mid-50s and is still widely practiced is total actual cost divided by units of output; that is, average cost. In other words, control-oriented concepts have been most heavily relied upon although the explicit aims of such studies have always been presented as being to aid resource allocation and to promote internal efficiency, uses for which marginal cost information would be more appropriate.

While early cost studies may be outdated, they should not be overlooked. The origins and uses of these studies provide readily available insights into the current body of knowledge and the process by which it evolved. In particular, these studies provide a knowledge of the specific educational environment and administrative needs to which these various methodologies were a response and for which they were deemed appropriate.[2]

To begin with, the attitude that efficiency must somehow be fostered in higher education just as much as elsewhere in the economy is not new. In 1911 Morris Llewellyn Cooke observed in a Carnegie Foundation report that there was a need for more efficient business methods and for standardization in university administration in order to afford more reliable

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[1] Sherer [268], p. 39.

[2] The GRADCOST Research Group is grateful to Harvey Sherer for his extensive annotated bibliography of literature on the costing of higher education, which suggested sources for many of the following references.

comparison among colleges.[3] Cooke was evidently aware that effective resource use was impossible without a well-defined and operational interpretation of the relationship between higher education objectives and net social benefit:

> One is struck . . . in any such study of collegiate conditions with the absence of any gauge of efficiency which even remotely resembles, for instance, profits in an industrial undertaking.[4]

It is difficult to say how widespread awareness of the problem facing decision makers in higher education was. What is striking about the above remark, however, is that it fully anticipates what remains, after six decades, one of the most urgent questions facing higher education. It would seem logical, therefore, to investigate the manner in which these questions have been dealt with over the period.

Questions concerning the appropriate measures of efficiency for higher education were frequently asked;[5] but understandably, answers to these questions were slow in coming. The problems and complexities involved simply in getting appropriate information have been referred to; but there appears to have been another reason for the slow progress as well. This reason, according to one administrator, was quite simply that public attitudes did not require it. In a study conducted under the auspices of the American Council on Education in 1925, special investigator Edwin B.

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[3]"Phases of Scientific Management: A Symposium," [239], p. 286.

[4]Ibid. An academic participant in this symposium showed similar awareness of such problems in the following remarks:

> No one can state the relation even approximately between the educational product and the efficiency of the heating plant. The dividends are in the unseen and intangible world. And this suggests a third question, "What is the standard and measure of the efficiency of the subsidiary departments of a college?"

[5]See, for example, the following sources: Birdseye [29], Kelly [174], Pritchett [242], and Veblen [323].

Stevens, (then Executive Secretary of the University of Washington), commented:

> The popular tendency to emphasize the intangible values of higher education is largely responsible for the fact that there has been a lagging behind on the accounting side of the management and operation of the institution.[6]

Stevens' remarks were addressed to the state-supported institutions of higher education. However, if the attitude was as pervasive as Stevens implied, it was probably appropriate for private institutions as well.

It is hard to believe that the scrutiny of educational spending was any less then, in proportion to the magnitude of funds involved, than now. What is apparent, however, is that the desire of funders and other constituencies of higher education for objective measures applicable to higher education was less exacting than now. There was an apparent willingness on the part of funders of public education, at least, to accept costs as synonomous with value of output. There is a clear presumption in all of the early cost studies that the value of education was appropriately measured by the value of resources used in producing it. It was generally accepted that while the benefits or outputs of higher education were not clearly known or capable of being valued, they were nonetheless worth the cost required.

This interpretation of cost as value made it important at a very early stage for administrators and funders alike to relate resource requirements to outputs. This is apparent in the many studies initiated by institutions themselves which attempted to focus on cost per credit hour, clock hour, contact hour, and so on, in order to compare institutions and educational programs with one another on the basis of such measures. There was even an apparent recognition of the need for incremental information. There was, however, no corresponding attention given to the value of benefits, either on an average basis or otherwise. For example, Stevens, in the American Council on Education study which he directed, pointed out that while average cost figures are appropriate for presenting the average cost of current outputs, marginal cost information was appropriate for decisions to commit resources in the future.

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[6] Stevens and Elliott [279], p. 8.

> It would be better to ask "What are you spending for instruction per student? What is the cost per student for reasonable efficiency? If additional students are admitted, what will be the additional cost?"[7]

But, even in this perceptive report there was no attention given to the role played by measurement of benefits in resource allocation. In other words, the attitude governing this and similar studies was that cost information was sufficient for resource allocation decisions.[8]

A glance at the introduction to any cost study written between 1900 and 1960 indicates that the stated role of cost allocation was a dual one, to justify a request for legislative appropriations or alumni donations, as well as to aid internal management. The intent of the Stevens study, for example, was one of "promoting economies in operation . . . [and] . . . supplying the argument for support."[9] The evidence suggests, however, that the latter purpose took precedence. Indeed, the first use of cost information was "to prove that a lot of students were not getting educational value."[10] Virtually every cost study conducted by institutions of higher education up to the present is prefaced by similar statements of dual purpose. However, nowhere is there mention of how such cost figures would actually serve the first purpose, aiding internal resource allocations.

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[7]Stevens and Elliott [279], p. 120. (Emphasis added.)

[8]We find "unit cost" studies like the Stevens report in the 1930s, 1940s, and 1950s. They all have in common the interpretation of cost as "educational value" and use of average costs. See, for example: Elliff [100], Nance [213], and National Committee on Standard Reports for Institutions of Higher Education [218]. In 1957, for example, in Lewis [191], p. 51, we find:

> Lacking an adequate way of measuring or even identifying the product in precise terms, it is still possible in many cases to develop significant measures of work load of subsidiary activities that contribute to the end product.

See also the following sources: Brubacher and Rudy [51], Elliott, Chambers, and Ashbrook [101], Morey [209], National Committee on Standard Reports for Institutions of Higher Education [219], Reeves and Russell [248], and Russell [254].

[9]Stevens and Elliott, op. cit., p. 27. See also Sherer [268], p. 38.

[10]Sherer, op. cit., p. 39.

Not surprisingly, the fact that costs were accepted as an indication of educational value influenced the role played by cost information in decision making. It meant that cost studies were in essence a part of the process by which higher education administrators "priced" outputs for their constituencies. Legislatures, alumni and other donors desired a more accurate basis for determining "adequate" levels of support.[11] However, the willingness on the part of funders to accept cost or input information as sufficient response to their demands for accuracy, objectively, and efficiency, made the cost study an important part of the budgeting process. Eventually, in fact, cost studies were used to develop budget formulas which enabled institutions of higher education to count on a given level of support per student enrolled in the institution.[12]

The fact that cost studies became such an integral part of the process by which support was negotiated also influenced the nature of information which was gathered. Since budgets were typically negotiated in lump sums rather than in increments over previous levels of support, legislators were more interested in knowing what the total cost of running the institution would be.[13] As a result, cost studies tended to focus on total costs or total cost per student, rather than marginal costs or the way costs varied with outputs.[14]

Another characteristic of the environment in which higher education existed was that higher education was not usually regarded as just another

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[11] This observation is made by many authors. See, for example: Miller [203], "Formulas and Cost Analysis," Chapter 4, p. 80.

[12] The manner in which this came about is very well documented in the Miller analysis above.

[13] Niskanen [227].

[14] A thorough and informative review of cost studies in higher education is found in Cavanaugh [66]. The author observes, as we have done, that:

> Most cost analysis systems, however, are directed only toward budget preparation at the state level and the information is rarely detailed enough to be a useful aid to internal cost control. (p. 11)

models are not good starting points for understanding university behavior:

> . . . what we know of the nature of decision processes in schools suggests to us that it is improper to conceive of the graduate social work process as a production process.[60]

In order to understand university decision-making behavior, therefore, recent authors have started with incentives:

> The ultimate aim of studying resource allocation in the field of education is optimization and this presupposes the existence of an objective function. Hence, it is prudent in the field of education, as with any other "business," to periodically examine the expected convergence of plans with organizational goals.[61]

One of the first observations which can be made in this respect is that the lure of profits and rigors of competition, which provide powerful incentives for efficiency in the marketplace, are absent in education.[62] Professor Allan M. Cartter, Chancellor and Executive Vice President of New York University, stated in a recent interview conducted in Chicago and reported in *The Chronicle of Higher Education*:

> Institutions have their own aspirations that will drive many existing doctoral programs to expand, regardless of national manpower needs.[63]

Another source has suggested that such aspirations may in fact be the result of the organization of management roles in higher education:

> Faculty are quasi-administration, quasi-employees and their self-interest may well conflict with optimum cost minimizing behavior.[64]

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[60] H.E.W. [308], p. 136.

[61] Harman [140], p. 7. See also: Cartwright [65], and Fouraker [115].

[62] O'Neill [230], p. V-9. See also Siegel [269], p. 15:. The point is that in universities there is no mechanism, (such as relative profits in business firms) which automatically signals management to switch resources in response to shifts in demand. To be sure tenure and other work rules hinder the switching around of faculty in response to needs.

[63] *The Chronicle of Higher Education*, Vol. V, No. 13, 1971, pp. 1-3.

[64] O'Neill, op. cit., p. V-10.

economic competitor. It is certain that the willingness of constituencies to accept cost as a measure of value reinforced this viewpoint. It is also certain that this environment did not generate much pressure for the development of analytical techniques for determining and comparing the relative social benefits of educational programs.

Discussions of higher education benefits generally tended to emphasize the intangibles. Initial demands for fuller understanding of the education process were usually met with responses such as the following:

> Neither the factory nor the home furnishes the model for the college; but if one must be chosen, let it be the home.[15]

While this remark was made in 1911, similar statements have appeared throughout the literature and continue to do so. In 1955, one author--objecting to the use of unit cost studies for resource allocation--stated:

> A university is not a factory; it is in the nature of a service organization. . . . A college is not a factory into one end of which is fed raw green freshmen. . . . Higher eduation is not a production process. . . . Effectiveness, not efficiency, in instruction is the essence of higher education. Our business is higher education, not financial reports on garbage removal or the unit costs of ash removal.[16]

This general attitude is also reflected in the notion that questions of program scale can be divorced from questions of program demand. A minimum program size was seen by at least one author as necessary, independent of program demand:

> Costs are not necessarily related to social values. It is just as important that freshmen students receive instruction in English, history, languages, and mathematics with the same degree of effectiveness as the senior in medicine, although the cost of teaching in one area is only a fraction of the cost in the other.[17]

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[15] "Phases of Scientific Management: A Symposium," [239], p. 286.

[16] Sherer [268], pp. 39-40.

[17] Williams [337], p. 329. Also see Williams [338], p. 28: A university has a social obligation to continue studies in certain areas even though costs are substantial.

The next question is, then, what economic forces determine these aspirations? On the most general level the answer is the budgetary process.[65] Recent attempts to understand the budgetary process in higher education all take specific account of the fact that budgets appear to be negotiated on the basis of input requirements. Justification of budget sizes is seldom made in terms of the value of the output, even when program budgeting is employed.[66] Studies of the budgetary process typically arrive at conclusions such as the following:

> Budget justifications, when demanded, are often stated in terms of what prevailing salaries are in other institutions, how poorly the department fared in the competition for scarce finances last year, or other similar measures. The fundamental question of <u>why</u> the department exists at all is never raised. Little or no indication is given of what the resource inputs to the department are contributing to the overall purposes and objectives of the university.[67]

Developing such models further leads to the following prediction for behavior over several budgetary periods:

> . . . the future budget allocation of a scarce resource is frequently dependent upon the full use of that resource in the current period. Administrators are aware that under-utilization in one period may very well lead to a lesser budget for the following period.[68]

The eagerness of academic departments to increase their command over university resources is seen as a natural consequence of the current budgetary process.[69] David Breneman, in *The Determinants of Ph.D. Production at*

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[65] Fouraker [115], p. 336, explains resource misallocation as follows: The attempt to merge the budgetary and market systems in the university has not been entirely successful because the rewards have been rationalized almost exclusively within the framework of the budgetary system. The administrator is budget-oriented and budget-justified; the faculty member is budget-justified but market-oriented.

[66] See, for example, Breneman [46], and Niskanen [227].

[67] Pinnell and Wacholder [240], p. 94.

[68] Rowe, Wagner, and Weathersby [253], p. 2.

[69] Breneman and Weathersby [48], p. 6.

A similar attitude is apparent in the more recent Henle report.[18] This report compared the university to a church[19] whose employees serve without regard for the demand for their services:

> The professional person has a commitment of service to society independent of payment.[20]

Such a philosophy does not reflect a great deal of realism where market forces are concerned. Yet another example comes up in the context of the recent court cases involving Marjorie Webster College. The initial decision in favor of the plaintiff moved the President of the defendant regional accrediting body to speak out strongly against what he felt were the implications of the court decision:

> . . . that education is a product, not a process; that a college is a property, not a community; and that a teacher is an employee, not an agent of his civilization.[21]

In other words, costing activities in institutions of higher education were carried out in an environment which did not demand benefit- or output-oriented information. Unit or average cost information was used as a "pricing" mechanism in order to present constituencies with the total bill for providing a given educational "package," (i.e., a given total enrollment and service mix). The literature does not indicate how such numbers were used with respect to resource allocation within institutions.[22] However, if they were so used, the reason must have been that more appropriate information was either too little understood or too costly to obtain.

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[18]Henle [143].

[19]*Ibid.*, p. 97:
. . . one can say that the university provides appropriate "support" for the faculty member precisely in view of his full professional life, just as the Church or the parish supports a priest in view of his religious life and service .

[20]*Ibid.*, p. 62.

[21]Koerner [186], p. 55.

[22]One review of recent cost studies conducted by various institutions of higher education concludes that use of cost information for:
. . . internal economy and efficiency within the individual institution occurs in only a few instances.
(Cavanaugh [66], p. 11)

Berkeley, 1970, proposed the following model of departmental behavior:

> Academic departments attempt basically to maximize prestige, which is defined as control over resources and placement of graduates in institutions of comparable or higher quality.

From this behavioral assumption the author derived a number of predictions concerning admissions, curricula, information, financial support, and other characteristics of academic departments on the basis of which he was able to predict with some success varying progress and success rates for graduate students in different departments. In other words, the result of the budgetary process is that:

> . . . departments are rewarded for maximizing <u>input</u> with no reference to the output of the process.[70]

The implications of such studies are that cost saving innovations and factor substitutions are presently not encouraged by an input-oriented incentive structure. One study has tested this hypothesis and concluded that there has been no change in productivity in education for the last forty years.[71] Another prediction which is derived from the budget maximization hypothesis and appears to be supported by the evidence is that there will be over-investment in education.[72] The current over-supply of Ph.D.'s in certain fields is taken by some as evidence which bears out this prediction.

An implication of such studies is that the principal determinant of differences in unit cost between schools or school systems may be the

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[70] Breneman and Weathersby [48], p. 6.

[71] O'Neill [230], p. V-10. See also: Breneman [47], pp. 17-19. Predictions to this effect were also made eight years ago by Seymour E. Harris in Harris [141], p. 561.

[72] Miller [203], p. 84. See also Firmin [108]; Judy [168]; Niskanen [227]; H.E.W. [308], p. 137; and Cartter [63], p. 35, where he predicted:

> . . . the seller's market for college faculty will quickly disappear in the early 1970's.

He added:

> It is . . . a serious question of public policy . . . whether or not it is desirable to encourage many new institutions to enter the doctoral field. (p. 37)

Change in the Environment of Public Support for Higher Education

The post-war period was marked by two significant changes affecting higher education. First, the federal government entered the area of financial support for higher education. Second, the magnitude of expenditures in higher education and graduate education in particular opened institutions to much more public scrutiny and criticism.[23]

The fact is that the federal government entered the area of higher education support at a time when much attention was being given in economic and other literature to the theoretical characterization of conditions for efficient operation of public services. A crucial element in the discussions which took place was emphasis on the notion that meaningful allocation decisions can only be made by considering costs in conjunction with benefits. Questions were asked such as the following by A. J. Vandermeulen in a 1950 article in the *Public Administration Review*: Is it possible by rearranging allocations to increase total service? Is it possible to provide more service by increasing the budget without increasing the burden on the private economy?[24] Formal answers to questions such as these were being developed in the economic and mathematical literature of the late 1940s and early 1950s. Authors such as Dantzig, Kuhn, Tucker, Arrow and Hurwicz were developing linear and non-linear programming models, many of which found application in the Defense Department and other federal agencies.[25]

The position that higher education should be subject to the same critical scrutiny and evaluation procedures as other users of public funds was now held by one of the major new clients of higher education. It is both interesting and instructive to examine the manner in which this notion was initially received in higher education and how the challenge of a new and more critical attitude was met.

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[23] See, for example, the introduction to Alden [5], p. 3.

[24] Vandermeulen [322], p. 11.

[25] Dantzig [88], Kuhn and Tucker [187], and Arrow and Hurwicz [15]. The article by Arrow and Hurwicz in this volume was written in 1950.

differences in the budgetary process to which they must adhere.[73]

In addition to the budgetary process, other constraints are mentioned as hindering improved resource allocation and decision-making procedures. The institution of tenure, it has been observed, can:

> . . . lead to the buildup within a general faculty of what by some is termed a "segment of mediocrity" or a "backlog of inadequacy," at least so far as graduate work is concerned.[74]

Proposed Alternatives for the Financing of Higher Education

The impact of studies such as these is to suggest areas in which higher education could make make more effective use of available resources. Proposals vary widely in the extent to which they involve reorganization of the existing institutional and financial framework. But they all have in common increased attention to the development and use of output measures--both for intermediate or support activities and for the primary activities, i.e., those which are directly involved in education, research, and public service. The spectrum of proposals is very briefly summarized in the following section.

Proposed alternatives come from at least three distinct sources: (1) the institutions themselves or bodies which represent them; (2) the federal government; and (3) independent observers, economists, educators, politicians, and administrators speaking or writing as individuals. The latter group, not surprisingly, is the one responsible for suggesting some of the most radical innovations. Among such radical proposals for altering the manner in which public education is financed is the concept of direct grants to students, or vouchers, which effectively force institutions to

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[73] H.E.W. [308], p. 137.

[74] Weaver [329], p. 13.

The new environment made decision making in higher education more difficult. Administrators were no longer charged only with the production of quality education and the maintenance of the tradition and heritage which were important factors in dealing with alumni and other private and public sources of funding. In addition, they were now forced for financial survival to bargain with the vast network of federal clients and on terms that put entirely new demands on information systems.

On the whole, acceptance of the new concepts by the higher education community seems to have prevailed.[26] In 1953, for example, one administrator took it upon himself to warn his colleagues:

> . . . those who support higher education, both privately and publicly controlled, are becoming increasingly insistent, and properly so, that specific evidence be provided which will give assurance of maximum utilization of resources.[27]

Reaffirming this idea in 1957, John Hicks wrote that the principle of least cost output production:

> . . . applies to an educational institution as well as to any type of productive enterprise. Given a certain educational goal, it is socially desirable to attain that goal by using the least expensive combination of factors.[28]

Other sources indicate that a similar awareness of the new facts of life for higher education has continued to develop. Father Henle, for example, acknowledged that:

> . . . accountability in the use of Federal funds is of the highest importance, and both the university and the academic personnel involved have a serious responsibility to see that salaries charged to grants and contracts have a proper relationship to the actual contribution of those involved. . . . [D]espite the complexity of the situation, ways must

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[26] Naturally there was resistance. See, for example, Sherer [268], p. 40. One of the reasons for resistance has apparently been fear of erosion of academic control. For example, Hull [159], p. 376, stated:

> In effect, such efforts [to create a uniform cost structure] shift the source of authority for departmental policy from the faculty to the administration.

[27] Kettler [177], p. 199.

[28] Hicks [147], p. 21.

compete for funds by competing directly for students.[75] In favor of this idea, the argument has been advanced that some state universities presently enjoy local monopoly power which can be abused in one way or another. Also, many state legislators are attracted by the possibility that out-of-state public or private institutions may be able to educate their students more efficiently. Against the idea, the point is made that the costs of administering institutional grants are much lower than for administering student grants.[76] Also, to the extent that a state's specific manpower or research needs are unique, they may justify maintenance of state-supported institutions.

The approaches taken by federal studies tend to suggest the centralization and standardization of educational programs:

> . . . it is clear that, to continue to merit public support in the long run, they will need to transform their ways of

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[75] O'Neill [230], p. V-12. See also Jencks [164], p. 19:

> The voucher system seeks to free schools from these managerial constraints by elminating their monopolistic privileges.

See also Koerner [186]:

> . . . [the] assumption that the profit motive is inconsistent with quality is not supported by the evidence and is unwarranted. There is nothing inherently evil in making a profit and nothing commendable in operating at a loss. (p. 53)
>
> The national interest is not best served by stifling competition from any available source. With the unprecedented demands upon educational resources in this country, every institution should be given the opportunity to demonstrate its worth. (p. 54)

[76] Both of these points were summarized by Roger Bolton [36], p. 70:

> Administrative costs . . . are probably much lower if aid is given to institutions, and this is an argument in favor of aid to institutions, as long as the aid is given to a wide variety of institutions. If the government gives aid to only one or to a few, as state governments often do, it is no longer true that the two kinds of aid produce the same results. . . . Their freedom is limited only by the elasticity of demand of the whole market facing them, not by the price and quality competition of other institutions . . . A rise in quality might then not be due to overwhelming demand for it, but rather to the tastes and energy of the trustees.

> be found to correlate the activities of the full professional life with financial remuneration.[29]

In effect, the attitude appears to have become more pervasive that higher education is in fact an economic process and does compete with other potential users for public expenditures, and that consequently, its budget is subject to the same critical evaluation as other demands for public funds. This change in attitude leads gradually to a re-thinking of the role and scope of planning and resource management in higher education.

Apparently, business accounting concepts were undergoing similar changes. The economic distinction between marginal and average costs, and uses for which they are appropriate, was beginning to appear more and more frequently in accounting journals.[30] One such article observed, for example:

> Frequently, averages computed at one volume are erroneously used for price decisions contemplating different volumes.[31]

In other words, it came to be clearly recognized that incremental decisions require incremental information.

These developments had an effect on attitudes toward the role of cost information in higher education. These effects can be summarized as the development of awareness that:

1. Costs are of little value unless considered in conjunction with benefits.
2. There is a difference between total cost of operating at a given level and mix of output and the cost of moving from one level and mix to another.

Articles in *College and University Business*, for example, contained remarks

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[29] Henle [143], p. 98. In a similar vein, see Zanfino [348], pp. 57-63:

> Whether we like it or not, the trend toward cost accounting for higher education is here. . . . Accurate cost records must be maintained to determine the amounts of money which will be necessary for specific departments or programs, existing as well as new.

See also Hirsch [148], p. 2.

[30] Kleerekoper [181]. See also: McMullen [201], Schmidt [263], Trafford [297], and Wright [347].

[31] Kempster [175], p. 28.

> thinking and doing business; specifically, schools will need to establish objectives, determine what exactly their inputs are, and to consider the logical and comparable relations between inputs and outputs.[77]
>
> The changes in school operation to which we have just referred are, to some extent, inevitable, but if no government action is taken, they are likely to require a very long time.[78]

The attitude apparently is that the government should take the initiative in encouraging schools to do this job:

> If the government does not take the lead, schools will proceed individually in their own directions, and the opportunity for learning from analysis of pooled experience will then largely be lost.[79]

Within higher education itself, proposals range from a broader reliance on loan financing to decentralization and reorientation of the internal incentive structure to outputs.[80] One alternative means of control which has been suggested is internal pricing or accounting, i.e., to make the user accountable for all services used. This would allow some decentralization of decision making. Control of departments would be achieved by having each "pay" for what is used by the department through revenues, directly, and other benefits generated by the department.[81]

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[77] H.E.W. [308], p. xiv.

[78] Ibid., p. xv.

[79] Ibid.

[80] Breneman and Weathersby [48], p. 7:

> The use of output measures in restructuring incentive systems is a much needed reform for higher education.

See also Campbell and Siegel [57]; Firmin [108], p. 202; and Stager [277]. The Firmin study states:

> Universities with highly centralized administrations explicitly allocate more university resources to the administrative function than do universities with decentralized administration, involving wide faculty participation.

See also Morrell [210], pp. 12-3.

For an example of loan financing alternative recommended by H.E.W., see recommendations of the Assistant Secretary for Planning and Evaluation in H.E.W. [308], pp. 31-9.

[81] McMullen [201], p. 51.

such as the following as early as 1953:

> An analysis of costs indicates only what has been spent and not what should be spent for optimum efficiency.[32]

In a 1955 volume of the same journal another author wrote:

> It is more vital than ever before for the educational administrators to know as accurately as possible how much it will cost to add . . . students to the present enrollment.[33]

In 1957 John Hicks further distinguished between the purposes for which the different types of cost information were appropriate. Hicks described marginal costs as being appropriate for planning changes in current operational levels,[34] while average cost information is more relevant for investigating the status quo. A unit-cost study is a "study of what actually goes into" education, i.e., "largely descriptive."[35]

Evolution of New Budgeting Techniques and the Lag in Their Application

Techniques which were required to make these new concepts operational were far more sophisticated and costly than the unit-cost study techniques which had been used previously.[36] All of them, however, signified one important change in the manner in which educational spending was both budgeted and analyzed. For the first time attempts were made to orient budgets to outputs. The practice of object accounting had long provided higher education management with information necessary for control on the input side of the production process. In short, object accounting allowed auditors to insure that money was being spent as budgeted. However, the need to differentiate accounting for control and

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[32] Kettler [178], p. 17. The same author says in Kettler [177], p. 200, that administrators "must know whether unit costs as well as total costs are increasing; they must know why."

[33] Rand [246], p. 25.

[34] Hicks [147], p. 22.

[35] Ibid.

[36] These techniques will be discussed in length in later chapters.

Conclusion

With little doubt, immense problems presently face decision makers in higher education. As one student has put it, the basic question which must be solved is:

> How can public institutions be made more accountable to the public and their constituents without a complete loss of identity, direction, or autonomy?[82]

Given the extensive community role which institutions of higher education have traditionally played, it is worth asking whether the two extreme reforms mentioned above can be effected without a loss of identity and direction by institutions of higher education. Would complete reliance upon marketization eliminate the diverse and intangible values for which society relies on the institution of higher education? Would government take-over and standardization destroy the traditions and heritage which may be among the most valuable assets of universities? These are questions which need answering before such reforms can be fully evaluated.

It seems likely, however, that some change in the financing and organization of higher education will take place. It also seems likely that it will ultimately lie somewhere between the two extremes mentioned. If so, the need for information on the benefits and costs of graduate education outputs will be no less urgent than at present, and may conceivably intensify. Consequently, efforts to identify, understand, measure and evaluate benefits as well as efforts to allocate costs to them will remain important.

In discussing the origins and nature of the modern university, G. W. Baughman has pointed out that the university has two choices before it:

> Either it will have to achieve internal coherence and present itself as an entity prepared to deal with the outside world on an integrated basis, or it will be integrated and assimilated into the outside world through larger extra-university organizations. If we believe in the values of

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[82]Breneman and Weathersby [48]. See also Weathersby [327], p. 1: . . . I seriously question whether education institutions founded upon the principles of scholarly inquiry and quality education can long exist disdainful of their many constituencies, insensitive to their environment, and morally uncommitted in a time of massive, visible, social malaise.

accounting for budget and resource allocation was beginning to be recognized.

> The traditional educational budget categories, used in federal, state and local levels, do not allow one to relate required resources (costs) directly to the specific outputs or goals to be achieved. Thus, current budgetary systems cannot in their existing form, substantially assist officials in deciding how to allocate scarce resources efficiently among the ever-increasing number of competitive activities or goals . . . [37]

In part, the promotion of fund accounting by the American Council on Education's *College and University Business Administration* represented a change.[38] Fund accounting gave consideration to the output side in that it oriented budgets to the source of funds or, in other words, the "clients" of the institution. If fund accounting was not explicitly intended to do so, it did allow more attention and control to be exerted to ensure that funds were being spent in the manner desired by clients.

It was not until the 1960s, however, that explicit attempts were made to relate budgeting to outputs. The term "program budgeting" or "planning programming budgeting systems (PPBS)" are used to describe this type of budgeting.[39] Numerous articles on PPBS pointed out that the difference between program and object budgeting is that object budgeting is designed primarily for control within budgetary accounts, while program budgeting is designed also to relate all budgetary accounts to the objectives of the organization.[40] While PPBS cannot manufacture information where

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[37] Hirsch [148], p. 2.

[38] A.C.E. [8].

[39] Again, these developments will be examined in more detail later on.

[40] Pinnell and Wacholder [240], p. 95. See also Millett [204], p. 128:

> Obviously these objects of expenditure do not have any meaning in and of themselves. Objects of expenditure are means to an end. The problem of program budgeting is to relate input resources to output objectives.

See also Hamelman [134], p. 43:

> Systems analysis and PPB merely provide a framework in which the interdependency among university objectives is formally

> university autonomy and the academic freedoms that are closely associated with this autonomy, then the university should organize into internally coherent patterns and prove to the outside world that it can and must afford this structure.[83]

Baughman goes onto say that the only way to accomplish this task is to make it clear that "the university is more capable of defining its proper total role and destiny than any outside group that it serves."[84] Certainly, a demonstration of this capability includes identification of resource inputs required for university outputs and the benefits, private and social, which they generate.

The effort jointly undertaken in GRADCOST takes a step toward solving these problems by summarizing the present "state of the art" in terms of the identification and measurement of benefits and costs in higher education, generally, and for graduate education in particular. There is little justification for the fear that an increase in information will be damaging to higher education. The advice of one educator speaking almost sixty years ago is still sound:

> It is my experience that a clear statement of the real facts in the hands of the friends of the university is the best available defense against prejudice and antagonism.[85]

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[83] George W. Baughman in collaboration with Ronald Brady, "Towards a Theory of University Management," Chapter 1 in Johnson and Katzenmeyer [165], p. 12.

[84] *Ibid.*, p. 13.

[85] "Phases of Scientific Management: A Symposium," [239], p. 28.

there is none, it is capable of revealing decision makers' preferences implicit in a given budget by indicating the resource requirements for programs within the institution:

> No two institutions may agree on the optimum mix between the various programs, but a PPB analyst can quickly apprise policy-makers of economic implications of alternative choices in the scale or content of program levels.[41]

While advocates of PPBS, statistical analyses, simulation modeling, and other complicated aids to resource allocation in higher education promised much from their use, successful applications of the new techniques tried so far have not to date been widespread. Evidence in support of this statement consists of two types. First, published and unpublished cost studies undertaken by institutions of higher education throughout the 1960s indicate little refinement over what was done prior to and through the 1930s. Second, particularly with respect to graduate education, there continues to be much discussion of resource misallocation and the need for reform.

Reliance on unit or average cost studies, sometimes for inappropriate purposes, is still common. There are, however, conflicting

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> [40]recognized. The tradeoff among institutional objectives is given implicit consideration if not explicit measurement.

See also Morrell [210]:

> The means by which resources are allocated should be shifted from a policy of updating last year's budget (input) to an evaluation of future results (output). (p. 12)
>
> Basing the budget on previous allocations tends to perpetuate the past, even though conditions have changed . . . [A] method by which present and proposed programs compete on an equal basis will bring overall objectives into proper consideration. (p. 13)
>
> The program budget is primarily concerned with results, rather than with a line-item analysis of resources to be expended. (p. 14)
>
> Unless the budget request document presents the work study program as a total expense, including indirect costs, evaluating the costs and benefits of such a program is impossible. Burying the associated expenses throughout the various departmental object codes makes the program indistinguishable. (p. 14)

[41]Pinnell and Wacholder [240], p. 106.

Appendix 1-A

ADDITIONAL SOURCES RELATED TO TOPICS MENTIONED IN CHAPTER 1

Allen, Harry S. *A Single Data System for Long Range Planning and Short Range Management.* Lincoln: Institutional Research and Planning, University of Nebraska, May 1966.

American Council on Education. *College and University Business Administration.* Washington, D. C., 1968.

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Bowman, Mary Jean. "The New Economics of Education," *Educational Sciences,* Vol. 1, No. 1, February 1966, pp. 29-43.

Breneman, David W. *An Economic Theory of Ph.D. Production.* Berkeley: Office of the Vice President--Planning and Analysis, University of California, June 1970.

Callahan, Raymond E. *Education and the Cult of Efficiency.* Chicago, Illinois: University of Chicago Press, 1962.

interpretations of the persistence of this practice in the literature. On the one hand, some authors criticize administrators themselves for being unaware of their own information needs. On the other, authors who have obviously had experience with applying the theoretical analyses point out that regardless of how astute the decision maker, improved information may often be so costly for a single institution to obtain and so complicated for day-to-day decisions that it may not be worth it.

On the critical side, remarks appear to focus on the absence of clear objectives motivating cost studies. One observer commented in 1961 that the purpose of institutional cost studies was still a dual one, to aid both external fund raising and internal allocations.[42] Essentially, the same observation was made at the end of the 1960s in a review of several higher education costing endeavors:

> At this point one is again faced with the essential paradox of cost analysis studies: that they were initiated for purposes of internal control over expenditures and are commonly considered to do just this, but their chief use has been for justifying additional expenditures by the state. Techniques for studying and controlling internal expenditures are probably no further advanced than they were in 1935.[43]

The fact that cost studies are still used for external fund-raising purposes suggests continued acceptance of cost as a measure of value on the part of funding sources. In 1966 an H.E.W. employee remarked:

> Up to now the Office has been accustomed to assess its programs in accounting terms: Giving numbers of dollars spent in various ways, numbers of people assisted, numbers of things bought of various kinds, numbers of teachers involved, and so on. But the ultimate purpose of most of these programs is better education; it would be reasonable to try to determine whether in fact they do lead to better education, and if so, how much.[44]

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[42] Evans and Hicks [104].

[43] Cavanaugh [66], p. 20.

[44] Mood [207], p. 5.

Carter, C. F. "The Economics of Higher Education," *The Manchester School of Economics and Social Studies*, Vol. III, No. 1. Manchester, England, January 1965.

Cartter, Allan M. "The Economics of Higher Education," *Contemporary Economic Issues*, pp. 145-84. Edited by Neil W. Chamberlain. Homewood, Illinois: Richard D. Irwin, Inc., 1969.

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Hungate, Thad L. *Management in Higher Education*. New York: Teachers College, Columbia University, 1964.

Jencks, Christopher. *The Limits of Schooling*. Cambridge, Massachusetts: Harvard University, 1969.

These remarks are virtually echoed by an Amherst College administrator in 1970:

> Today's accounting systems at colleges are primarily cost oriented. Each expenditure is recorded by the spending activity or by the purpose for which it was made. Little or no effort is devoted to the benefits received for funds expended. To achieve a measure of cost effectiveness requires that something be compared with the cost involved.[45]

Similarly, authors of a study on university behavior in the South found that internal decisons were still being made on the basis of cost information derived from budget formulation procedures, rather than from analytical study.[46] In 1969 a major medical average cost study was prefaced with the intent of being a basis for negotiations with granting and contracting agencies and other financial supporters of the medical centers, and for cultivating new sources of income.[47]

Recent remarks by political figures convey similar concern for lack of attention to benefits. For example, in 1970, the following comments appeared in the *Chronicle of Higher Education*:

> Educators traditionally think in terms of inputs--new programs, more dollars for educational materials, higher teacher salaries, and the like. . . . [48]

Further:

> But we don't seem to know what the kids are learning, what they actually know, and what they can do as a result of going to school. . . . If the university in our society is to obtain increased resources for its operation and its capital plant, then society must be convinced that the university serves a useful social purpose.[49]

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[45]Morrell [210], p. 18. Of five formulas proposed for budgeting of federal aid to higher education only two used degrees granted; all others were based on expenditures or enrollments. Farrell and Anderson [107].

[46]Firmin, et. al. [108], p. 4.

[47]Campbell [59], pp. v and vi.

[48]Governor Russell W. Peterson of Delaware, the New Chairman of the Education Commission, in Semas [266].

[49]Ibid.

Kershaw, Joseph A., and Mood, Alexander M. "Resource Allocation in Higher Education," *American Economic Review*, Vol. 60, May 1970, pp. 341-6.

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Richards, John R. "Are We Asking the Right Questions?" *Quality and Opportunity in Higher Education*, pp. 95-101. Boulder, Colorado: Western Interstate Commission for Higher Education, 1959.

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University of California (Berkeley). *Outline of Study: The Efficiency of Graduate Education*. 1967.

In a similar vein, U. S. Representative Edith Green (D-Ore.), Chairman of the House Special Subcommittee on Education, said educators who are

> . . . oriented toward academic degrees and sometimes literally submerged in the "wonderfulness" of these degrees [must explain why they] seem not to care about producing a surplus of Ph.D.'s and quite honestly pay little heed to relevant manpower predictions.[50]

There are, of course, many such sources which show dissatisfaction with the decision making process in higher education.[51]

More objective evidence of the limited success which sophisticated decision making techniques have had, either in acceptance or application, is given by the growing literature concerning over-supply of graduates at the Ph.D. level in certain areas. In the mid-1960s Dr. Allan Cartter projected an excess supply of Ph.D.'s by the 1970s.[52] A recent article has noted the failure of university administrators to respond to these apparently accurate predictions:

> The current crop of bitter, unemployed Ph.D.'s are bearing the costs of that misallocation of resources.[53]

The preceding observations imply, more or less directly, that administrators in higher education may themselves be in large part responsible for the lack of appropriate information and for resource misallocation. This is not, however, the entire picture. As mentioned earlier, even the

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[50]Semas [266].

[51]Numerous remarks could be cited which are critical of the manner in which graduate education is funded, organized and administered. While the tone of the following sources is not as constructive as one might desire, the sources are nonetheless instructive in that they represent a fairly broad segment of society and seem to form a consensus that management of higher education is: "irrational," "naively planned," "tradition bound," "wasteful, "foot-dragging," "elitist," "uninspired," and "inefficient." This collage of criticisms represents the combined judgments of the following sources: Breneman and Weathersby [48], p. 50; Cavanaugh [66], p. 14; Hamelman [133], p. 8; Harman [140]; Judy [168]; Rourke and Brooks [252], p. 155; H.E.W. [308], pp. xiii, xvii, 64, 71, 72, and 74; Weathersby [327], p. 11; and Weaver [329], p. 101.

[52]Cartter [63].

[53]Breneman and Weathersby [48], p. 7. See also: Anderson and Duren [11], and Stubblebine [283].

Vaizey, John. *The Economics of Education.* London: N. Y. Free Press of Glencoe, 1962.

Villers, Raymond. "Control & Freedom in a Decentralized Co." *Harvard Business Review,* March-April 1954, pp. 89-96.

conceptual literature is inconclusive as to the feasibility of choosing the "best" level and mix of higher education outputs. The Technical Committee on Costs of Higher Education in California complained of the limited payoff to even the best intended self-analysis:

> The fact is that the optimum student/faculty ratio for any particular situation is not known. . . . [54]

Furthermore, comparisons of educational institutions with other economic units is not entirely valid because of the different environments in which they exist:

> . . . while institutions of higher education, like most other public or quasi-public agencies, must buy all of their inputs in the marketplace (faculty, personnel, supplies, services, and capital) they do not sell their outputs at all and, therefore, have no source of external explicit evaluation of their products.[55]

In general, there are no commonly-accepted evaluative measures for outputs. Adequately tested management information systems, while they exist at some institutions, have yet to receive general acceptance.[56] Observations to the effect that if the quantity of higher education resources devoted to activities and the benefits of each activity were known it would be possible to rationalize resource allocations among them,[57] amount to little more than wishful thinking.[58]

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[54] Technical Committee on Costs of Higher Education in California [288], p. 50.

[55] Weathersby [327], p. 3.

[56] Van Wijk, Judy, and Levine [320], p. 9. Van Wijk and Levine have also suggested remedies for the situation in Van Wijk and Levine [321]. Also, efforts are planned by WICHE to develop such systems; see Farmer [106].

[57] Siegel [269].

[58] Conclusions of H.E.W. [308]:

> For most schools it appears not to be even a relevant question whether greater output could be achieved with the same resources, partly because there is no accepted concept of outputs. (p. 136)

CHAPTER 2

THE BENEFITS OF GRADUATE EDUCATION

Introduction

Benefits, or anticipation of them, are the appropriate justification for committing resources to higher education. The present chapter summarizes current means of defining, measuring, and evaluating the outputs of graduate education. The intent of the chapter is to review in cursory fashion the "state of the art" of dealing with these problems.

Graduate students participate in teaching, research and sometimes the public service activities of the institution of higher education; draw on the environment for learning; are among the recipients of knowledge which is distributed; and also create new knowledge in the course of thesis and dissertation activities. From all of these activities, the graduate student derives benefit. The question at hand is, what are these benefits and what are they worth to the student and to society as a whole?

While a clear distinction is not always maintained in the literature between the terms "output" and "benefit," it will be helpful for our purposes to define as outputs those results of graduate education activities which are visible and immediately identifiable, and to define as benefits the reasons why outputs have social value. For example, the Ph.D. degree in a given discipline is an objectively identified output which may be valuable because it signifies increased earning power and an increased ability to enjoy life through understanding for the individual, and a larger tax base, as well as more responsibile citizenship, for society at large.

Section 1 describes measurements of graduate education outputs. Section 2 deals with the benefits--which accrue to the individual student, to the institution, and to the public at large--of graduate education. Section 3 describes the techniques for evaluating graduate education

To summarize, the conclusion to which a review of current literature leads is that external funding and budgeting decisions in higher education still rely primarily on historical unit costs and judgment, rather than on sophisticated cost projections. But since there is pervasive doubt as to the feasibility of coming up with anything better at reasonable cost, failure to do so should not be blamed on those who are constrained by limited resources in their costing efforts.

It is important from the standpoint of perspective to point out that the procedures used in allocation decisions by private industry do not appear to have developed at a much faster rate. The accounting literature which deals with marginal cost pricing does not give the appearance of being significantly more operational than articles which relate these concepts to higher education.[59] Also, the point is well taken that while cost is still accepted as an estimate for value, it may not be representative of such. Again, however, the observation must be made that there simply is no objective value criterion available to decision makers in higher education. The literature does provide a starting point for benefit measurement at least with respect to private monetary benefits but the low level of confidence which can be placed in the numbers available to date and the crudeness of techniques available for predicting market conditions mean that it will be a long time before planners can fully supplant the market even to the extent that it does operate correctly in the perception of benefits.

Recent literature on resource allocation and decision making in higher education has begun to focus in a more constructive way on the problem of decision making. Past willingness to accept costs as a measure of benefit has created an incentive structure related to resource use rather than output. Some authors have recently begun to examine carefully the incentive structures which do exist in higher education. A recent study of social work education, for example, concluded that input-output oriented

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[59] Kempster [175].

outputs. Four techniques and examples of them are summarized in this section: input evaluation, estimation of earnings differentials, estimation of static demand for graduate education, and estimation of growth in national income due to graduate education.

The Outputs of Graduate Education

While complexities exist and measurement of graduate education outputs may be imprecise,

> . . . these complexities are no justification for believing that it is useless to endeavor to identify outputs from a higher education enterprise.[1]

This view is representative of most of the literature on higher education outputs.[2] Obviously, output measures are central to the relationship between costs and benefits. For purposes of resource allocation decisions, managers must know both what an additional unit of output will cost to produce and what it will be worth to society. In order to determine what the _net_ contribution to society is, managers must know the total cost of producing the current level of output, as well as its total value to society. Clearly, the output measure itself serves as the fulcrum for weighing costs against benefits. According to John D. Millett:

> The purpose and the organization of higher education (and within organization, the process of higher education) obtain concrete meaning only in terms of units of production. . . . The concept of output can surely be applied to higher education without imposing some intolerable burden upon the learning process.[3]

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[1]Millett [204], p. 51.

[2]In fact, the need to relate the benefits of graduate education to identifiable outputs which generate them is referred to often. For example, see Kettler [177]:

> Quality must be related to the end aims and objectives of the institution.

See also Black [31], p. 9:

> There needs to be a rationale which guides the university to a particular enrollment and tuition policy equivalent in its milieu to profit maximization for the business firm; only by finding an adequate objective can cost-benefit analysis of university operations generally obtain analytically sound footing.

[3]Millett, _op_. _cit_., p. 4.

For purposes of relating costs to benefits, the ideal concept of output is the simplest measure of the results of an activity which correlates closely with resources used and benefits generated. It is understood that a graduate degree utilizes numerous intermediate outputs, such as lectures, seminars, independent study credits, research experience, student-related services, association with teaching and research faculty, internship, subsidiary services, organizational and administrative services.[4] To the extent that these intermediate outputs are provided to students in the course of degree work or in the course of some chosen program of study, they are embodied in whatever output is realized at the end of that course of study. It may be a degree, a transcript representing partial completion of degree requirements, or certification that a course has been completed.[5]

The important point in this discussion so far is that for measurement purposes it is not necessary to consider <u>all</u> outputs in the education process. As long as intermediate outputs are required for outputs at a later stage in production, the latter output or outputs can be used as a measure of the total.

Of course, final outputs may contain intermediate goods in different proportions. For example, most degrees consist of elective, as well as required, courses; and independent study or other options are sometimes substitutable for such requirements as field examinations. The acceptability of electives suggests, at least, that the quality of degrees, and therefore homogeneity of the degree measure within programs, are not altered by such variations. However, to the extent that they are, accurate measurement requires differentiation of degrees according to variations in content.

In other words, measurement can focus on those results of graduate educational activities which are valuable for their own sake at the end of the production process and which embody various intermediate goods. To do otherwise is to complicate the measurement process unnecessarily by making

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[4]More or less comprehensive discussions of these outputs are found in the following sources: Firmin [108]; Henle [143]; Lawrence, Weathersby, and Patterson [190]; and Swanson, Arden, and Still [284].

[5]For further discussion of degree components see Spurr [274].

it redundant.[6]

Although acceptance of degrees as a representation of the output of the graduate instructional process appears widespread,[7] it may be that the degree cannot serve as the exclusive measure of all of the valuable results of graduate instructional activity. For example, not all students who enroll complete a degree program, and by the degree measure they would have no output associated with them, even if they completed all but a few of the requirements.[8] In order to take account of the fact that such training still has value, even though not enough to satisfy full degree requirements, it may be desirable to take account of parts of a degree earned by dropouts.

At most American universities the distinction is made between achievement at the Master's level and at the Candidacy level. It is possible, therefore, that satisfaction of normal degree requirements at the Candidacy level may be measured as an output of graduate education.[9] Even in the absence of formal certification, a student's transcript may serve as the documentation of outputs which are less than the complete degree.

The question of whether or not to consider anything less than full satisfaction of degree requirements as an output or simply as waste is, however, unresolved in the literature. On the one hand, in some cost studies dropouts are considered as having no value at all and the cost of

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[6]See Millett [204], p. 59:

> . . . it is possible and reasonable to say that degrees awarded represent the true output of the instructional process.

Since learning experiences gained by matriculating students are always proportionate to the number of degrees, the degree itself is an adequate measure of the training output for matriculates of graduate education.

[7]The U. S. Department of Health, Education and Welfare has kept records of enrollment and Ph.D. output in scientific fields at 100 institutions. See, for example: National Academy of Sciences [214]. See also records for 1920 to date (Publication #1142 for 1920-62; Publication #1489 for 1958-66), and H.E.W. [307].

[8]Millett, op. cit.

[9]Pugliaresi [243] discusses the question of the Candidate in Philosophy degree with reference to the experience at Berkeley.

their education is allocated totally to the completed degrees.[10] On the other, some authors argue that as long as these fractions of the total degree program have value in and of themselves they should be considered outputs:

> Too much emphasis is placed on the receipt of diplomas and too little on a willingness to meet foreshortened practical ends with activities that need not, and should not, get mixed up with academic goals designed for another purpose.[11]

Apparently, the question is one of value. One test which might be used, therefore, is willingness to pay. If students, their prospective employers, and/or their funders are willing to pay for non-standardized amounts of education then there is no question that such education has value.[12]

In some cases clients of the institution may be interested in pursuing even smaller fractions of programs offered in graduate education. Whether or not attendance at a single graduate seminar may be defined as graduate training, that seminar is nonetheless an output of the graduate education process. The very fact that such outputs have value in and of themselves and not necessarily in the context of a degree program is reason for recognizing them as outputs of the graduate education process.

In addition to the degree, or parts of it, there are other outputs of the graduate education process which may be considered final outputs in that they are not simply components of the degree. For example, while teaching experience, research experience, and--for some disciplines--experience in the practical field application of techniques learned (e.g., Agriculture, Engineering, Social Work, Architecture, etc.) are required for the degree, all such experiences involve the production of what may be termed "joint outputs." Teaching and research assistants provide valuable outputs to the institution they attend.[13] The dissertation activity results

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[10]This is done in Hamelman [132], p. 12.

[11]Weaver [329], p. 27.

[12]Ph.D. attainment and attrition is discussed in the following four sources: Creager [83], Creager [84], Pear [236], and Stark [278].

[13]For a discussion of costs associated with teaching assistantships, see Chase [71].

in a contribution to the stock of knowledge which is available to the public at large, although it may or may not be valuable enough to be published. Demonstrations, projects, experiments and so on also result in the contribution of scientific and cultural outputs either to the university community, the local government, or the society at large. All of these outputs are joint products of graduate education activities; but because they have value in and of themselves and are not simply intermediate goods involved in degree output, they should be included in any list of outputs of graduate education.

The Benefits of Graduate Education

Four specific outputs of graduate education have been identified:

1. The degree.
2. Parts of a degree, from individual courses to parts of a degree program.
3. Outputs jointly produced in the course of graduate education activities and used elsewhere in the university.
4. Outputs jointly produced as a result of graduate education and made available to society at large, (teaching and research assistantships).

Benefits have been defined as the reasons for which outputs have social value. Before discussing the attempts which have been made to evaluate the outputs mentioned and the techniques used in such evaluation, it is important to characterize benefits generated by these outputs in order to gain insights into constraints on their evaluation.

The degree may have value to a single beneficiary for more than one reason. To an individual, for example, the degree represents certification of newly acquired skills, some of which may be highly marketable. At the same time, different stages in the process of acquiring the degree may have provided benefits in terms of personal satisfaction and enjoyment, both during the process and later on. Also, a single output may have more than one beneficiary. This can be true even if claims to the output rest exclusively with an individual, as in the case of a degree. If the degree is financed in part by income transfers (subsidies) from taxpayers, alumni, and private donors, this willingness to pay is evidence of benefit somehow perceived from these segments of society.

It is important to note here that the public may be benefited by graduate education in two ways: (1) from outputs which accrue to the public directly; and (2) from outputs which accrue to private individuals. The public may receive actual outputs, or goods and services which are produced jointly with other outputs and are made directly available to the public at large or to certain segments of it. Public lectures, recitals, free access to or participation by the public in graduate education activities, and other services to the public which result from the process of graduate education may be defined as public outputs of graduate education. Like the dissertation, which is a contribution to the public stock of knowledge resulting from the degree outputs, such services may be considered joint products of the graduate education process.

On the other hand, the public may benefit also from outputs which do not accrue directly to them. There may be reasons why the degree is valuable to the public at large as well as to the individual trainee. Many authors refer to the increased responsibility of citizens which comes as a result of their having achieved a college or university degree or even part of a degree. Such benefits, since they may be attached to the outputs which are owned by private individuals, are sometimes called <u>external social benefits</u>. They should be distinguished from joint products which occur with outputs of graduate education; they are, instead, joint benefits which are derived from a single product. The respective values of joint outputs added together form the total value of the results of a joint-producing activity.[14]

To focus attention more clearly on the factors which give value to the outputs of graduate education, a table has been prepared on page 48 which distinguishes the benefits commonly attributed to these outputs, both by type of benefit and by beneficiary. The table will be helpful in

[14] It becomes crucial in any costing exercise to be able to evaluate each output of a joint production process separately. This point will be elaborated in Chapter 3. Basically, however, the point may be outlined as follows: In order to determine the cost of <u>training</u> outputs of graduate education, it is necessary to subtract from the total cost of production the value of outputs which have been jointly produced with the training outputs but do not accrue to the student along with those outputs.

Table 2-I

BENEFITS OF GRADUATE EDUCATION

Outputs	Beneficiaries		
	1. Private (Student)	2. Other Clients of Institution	3. Public
1. Degree Program	Future Enrichment of Life Additional Marketable Skills: Teaching Research Management Prestige	Faculty Teaching Experience Faculty Research Experience Future Alumni Donations Current and Future Constituency Support Future Prestige	Redistribution of Income Additional Tax Revenues "Intangibles"
2. Parts of Degree (Less than 100%)	"	"	"
3. Results of Teaching and Research Assistantships	Student Teaching Skills Student Research Skills	Student Teaching Effort Student Research Effort	
4. Outputs Jointly Produced with Graduate Education (e.g., dissertaions, public lectures & recitals, public use of physical facilities)	Present Enrichment from Campus Life	Distribution of Knowledge New Knowledge Cultural and Scientific Events	Distribution of Knowledge New Knowledge Cultural and Scientific Events

maintaining the distinction between outputs, benefits and beneficiaries in the following paragraphs.

Benefits to the Student

The most specific literature concerning the benefits of graduate education relates to the value such education has for the individual degree recipient. Economic benefits which accrue to the degree recipient consist of additional lifetime money income resulting from the additional skills acquired during graduate education or simply from a preference on the part of the employers for educated employees. Such skills are teaching, research, and management. Some authors add that additional money income may be generated by such intangibles as the prestige of having gone to graduate school.[15] Such benefits are responsible for the analogy which is sometimes made that the graduate degree is similar to a durable investment good which yields benefits in periods after the one in which it was manufactured.

In addition to the future additions to money income which a degree may represent, there are increased personal rewards which may accrue to the individual, both during the process of graduate education and afterwards. One author estimates that about two-fifths of the expenditures on higher education are used to increase consumption content beyond what is generated as a by-product of the productive core.[16] With respect to current consumption benefits, one author points out that enrollment makes available to the student intellectual and athletic activities whose purpose is as much recreational as educational.[17] Another author suggests that current consumption services are also provided to the parents of college students.[18]

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[15] Campbell and Siegel [57].

[16] Danière [86], p. 209. The point is attributed to T. W. Schultz, "Investment in Human Capital," *American Economic Review*, Vol. 51, pp. 1-17.

[17] Campbell and Siegel, op. cit., p. 4.

[18] Fouraker [115], pp. 333-5.

The notion that consumption benefits accrue to the degree recipient, both during and after the education process, suggests that the benefits of graduate education also contain a consumer investment good, which provides a stream of consumption services over time. One author, in fact, takes the apparent popularity of degrees which evidence low monetary returns relative to other graduate fields as a measure of the extent to which consumption benefits exist in such fields:

> Since there are literally thousands of graduate students in the humanities who aspire to become college teachers and who probably have some idea of the low financial rewards which await them, there is probably something to this notion of large psychic benefits to an academician.[19]

Although most authors acknowledge that such benefits do exist, many point out that the type of psychic benefits depends on the type of education and that current consumption components of the benefits associated with graduate education degrees are probably not uniformly distributed across programs or even within them.

It must be reported, however, that the literature is inconclusive on the matter of the consumption value of education. In defense of the argument, it is pointed out that education widens the range of choice and the understanding of alternatives available to the individual.[20] On the other hand, it is pointed out that the process of education is one of changing tastes:

> It is the essence of the education process that it changes attitudes, expectations, and preference patterns: It takes Beatle maniacs and turns them into Bach lovers. . . . There are indeed arguments that it is an essential purpose of the educational process to produce such a change. . . . Should we not deduct the (notional) "loss" of consumption that this latter change implies?[21]

Similarly,

> Casual empiricism suggests that the educated person certainly lives differently, and allocates his consumption

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[19] Ashenfelters and Mooney [18], p. 253.

[20] Campbell and Siegel [57], p. 2.

[21] Wiseman [342], p. 4. Schultz [264], p. 13, answers this question in the negative.

> expenditures differently, but that he may not really enjoy life any more.[22]

One author caricatures the dilemma as follows:

> How does a pig know whether it is better to be a pig than a philosopher? And how does a philosopher know?[23]

Benefits to Other Clients of the Institution

Benefits which accrue to the other clients of the educational institution as a result of offering degree programs and awarding degrees are partly of a deferred nature. Once a student is officially enrolled in a graduate school the current and future constituency of the institution is automatically enlarged by one. Whether or not and in what capacity the student becomes a member of the matriculated alumni, he is a potential source of alumni donations and other support. Successful completion of degree requirements and job placement, as well as on-the-job performance, are elements in the prestige of the degree-granting institution and hence its future graduates and employees. Of a less remote nature, the teaching experience and research experience gained by faculty members at the degree-granting institution in the course of the graduate education process may enhance their ability to perform these functions in the future.[24] The process by which such changes in productivity come about has been referred to by economists as "learning by doing."[25] Finally, the teaching and research output provided by enrolled graduate students (teaching and research assistantships) are outputs which benefit other currently enrolled students and research clients of the educational institution.

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[22] Bolton [36], p. 33.

[23] Wiseman [342], p. 4.

[24] This point is mentioned by Firmin [108].

[25] Becker [25], and Mincer [205].

Public Benefits

Public benefits which may be the result of degrees granted are similar to the private benefits. In the first place, additional money income for the individual means additional tax revenues for the government. Over and above these monetary benefits there are, according to some authors, intangible benefits variously described as "neighborhood effects," "liberal values," "preservation of knowledge and culture,"[26] and "growth in society at large."[27]

On the existence of such social benefits from graduate education many authors are affirmative. For example:

> I agree with those who claim that there are major social returns to higher education in addition to private returns, and that, therefore, there is a case for substantial public financing of higher education. . . .[28]

Such statements are common in the literature. However, identification of the social benefits being referred to is not often specific.[29]

Sources which deal with benefits to society at large generated by graduate education outputs are too numerous to review here.[30] It is possible, however, to group the sources into three general categories. The first and largest category includes sources which deal with the social benefits of education in a general way. These sources typically do not differentiate between undergraduate and graduate education in the identification of benefits which society derives over and above the personal benefits received by the student from education. The second category is similar to the first

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[26]Bolton [36], pp. 34-5. Bolton also identifies the discovery of talent as a major social benefit resulting from graduate education. See also Weisbrod [330], pp. 106-23.

[27]Brown [50], pp. 27-38.

[28]Balderston [23], p. 1.

[29]Social benefits are classified in a general way in Weisbrod [331].

[30]Helpful discussions of "spillover" benefits, as well as costs, are found in the following sources: Hirsch and Marcus [149]; and Hirsch, Segelhorst, and Marcus [150].

except that more attention is paid to the benefits generated by public financing of higher education at the state level. The third category, and the smallest, consists of those sources which deal specifically with the public benefits of graduate education. A representative list of sources in each category is presented at the end of this chapter (Appendix 2-A).

Some authors do, however, completely discount the possibility of valuable intangible benefits to graduate education. Economist Milton Friedman, for example, denies that there are any.[31]

The Provision of Equity

One social function of higher education which has received much attention in recent literature deserves separate mention. This function is the provision of equity by making higher education and the consequent increase in earning power available to the poor.[32] The concept of equity is not clearly defined in the literature and there is apparently confusion as to just how it is to be interpreted. There are apparently two concepts of equity. For the sake of discussion, we shall refer to these concepts as the "egalitarian concept" and the "efficiency concept."[33] The "egalitarian" notion of equity goes something like this: Any individual should have access to higher education regardless of his ability or willingness to pay

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[31] Friedman [116], p. 109. Also see Butter [53], p. 2, where she assumes there are none.

[32] General discussions of the provision of equity through higher education appear in Carnegie Commission on Higher Education [60]. A qualitative investigation of the distribution of graduate training benefits is contained in the following source: Gropper and Fitzpatrick [125].

Several articles have attempted to measure the effect of education on the distribution of earnings; see the following sources: Becker and Chiswick [27]; Cohn, Gifford, and Sharkansky [75]; Hanson and Weisbrod [139]; and Pechman [238].

Theoretical models for the provision of equity through institutional admissions policies have begun to appear. See Hoenack [152], and White [334].

[33] These labels were created by the authors for the purpose of maintaining a distinction between two notions of equity which appear to occur in the literature.

for it. The "efficiency" notion of equity is similar except for one point: the student must be willing to pay for the benefits he receives either during or after the education process.

The former notion is one which is likely to be in conflict with efficient use of social resources. The latter one is not. The reasoning behind this statement is not difficult. The "egalitarian" notion of equity is one which interprets equal opportunity as a redistribution of wealth. In this case the wealth is in the form of resources used in the course of education. No attempt is made to determine whether the benefits to be derived by both society and the student from a gift of wealth in this form are worth the resources used. In fact, one can say with some certainty that for the marginal student, i.e., the one who is just willing to undertake education which is subsidized, the benefits do not justify the full social costs.[34] The "efficiency" concept, on the other hand, requires that the student expect benefits which are at least worth the cost.[35]

The existence of these two distinct notions is responsible for two trends which appear in proposals for financing of higher education generally. The "egalitarian" notion of equity leads to a system of state subsidy.[36] The "efficiency" notion of equity, on the other hand, leads to a system of loan financing, such as was recently recommended by the Assistant Secretary for Education and Development in his report to the President of

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[34] Further implications of the conflict between these concepts of equity may be found in Hansen and Weisbrod [139], p. 109, and in Becker and Chiswick [27], p. 362.

[35] For a comparison of alternative financing schemes see Daniere [85]. See also Kaysen [171]. For institutional discussions of pricing education to the student see the following two sources: Coordinating Council for Higher Education in California [79], and North [228].

[36] One of the most commonly-found arguments against such a system is that a general subsidy should not be needed if the student expects to gain from his education. Black in [31], p. 40, says:

> From a pricing point of view, one of the extraordinary practices of the university is the practice of reducing the costs of education through scholarship for those students for whom the return from education is likely to be greatest.

the United States.[37] Proposals such as those by Economist Milton Friedman fall into the latter category:

> It is then eminently desirable that every youngster, regardless of his parents' income, social position, residence, or race, have the opportunity to get higher schooling, provided he is willing to pay for it, either currently or out of the higher income the schooling will enable him to earn. There is a strong case for providing loans sufficient to insure opportunity to all [but] there is no case for subsidizing those who get higher education at the expense of those who do not.[38]

The argument is frequently made that individuals who could benefit from higher education may be restrained from so doing by inequities or imperfections in the loan market which limit their access to financing <u>even if they are willing to pay</u>.[39] Such restrictions on the availability of loan funds mean that in the absence of guaranteed or low-interest loans provided by federal and state governments or the institution itself, the talents of less well-to-do individuals will be wasted.

> The native ability of young people is one resource available to us, and optimum use of it requires that more of other resources--teaching hours, classroom space--be applied to more-able than to less-able minds. If one accepts that intelligence is distributed normally, the evidence on income and college attendance clearly suggests that education investment is not now being channeled wholly according to native ability.[40]

These remarks also point up a contingent social function played by higher education in the discovery of talent.[41]

Those who favor government participation in loan markets to eliminate wasteful inequities also feel that a system of indiscriminate state subsidy merely perpetuates such inequities. The reasoning here is that

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[37]H.E.W. [306], pp. 31-9

[38]Friedman [116], pp. 109 & 112.

[39]See, for example, Black [31], p. 15.

[40]Bolton [36], p. 66.

[41]See Williams [336].

indiscriminate subsidies cannot distinguish cases where loan financing has been denied or restricted arbitrarily from those where there is simply no willingness to pay out of future income for the benefits gained:

> Programs which provide higher education to specific (low-income) groups may be justified, but general public subsidies to higher education have usually increased the degree of inequality in the distribution of income.[42]

There is one point on which the distinction between the two notions of equity mentioned above breaks down. No one has perfect knowledge of the future. Furthermore, if expectations are conditioned on the basis of past experience, it may be that individuals from poor families systematically underestimate the benefits to be derived from graduate education. In such an event even low interest loans to finance graduate study may not induce such individuals to go to school.[43] The alternatives are outright subsidies to lower the costs to the student and bring them in line with the benefits which he actually does expect, or, a relatively recent development, to tie repayment to additional future income which is actually earned by the students. This latter financing scheme, which is currently being tried at Yale and is under consideration in Ohio,[44] allows risk sharing among students.

Evaluating the Benefits of Graduate Education

Resource allocation decisions in graduate education, as in higher education generally, would be facilitated by more precise information concerning output values. In particular, information concerning the total or average values of outputs is needed in order to determine the rate of return on current investment in graduate education; information on the marginal values of outputs is needed in order to determine levels of investment consistent with maximum effectiveness of resource use. The differences between these two types of information are subtle. The total value of a

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[42] Singer and Feldman [271], p. 134.

[43] Black [31], p. 15.

[44] See recent issues of *The Chronicle of Higher Education*, particularly Vol. V, No. 25, March 29, 1971, p. 1.

given output level can be compared with the total cost of producing it in order to determine the rate of return on investment.[45] Marginal values, on the other hand, are appropriate for ex ante decisions concerning changes in the level of output. At an output level for which marginal benefits have diminished to a point where they are equal in value to marginal costs, maximum effectiveness of resource use is obtained. A smaller output level means that net social benefits could still be gained by additional production, while a larger output level would produce greater additions to costs than to benefits.

A positive net rate of return signifies that the current level of investment is at least worthwhile, since total benefits are greater than total costs. However, the rate of return information does not indicate the precise level of output which is optimal. Determination of this level requires a knowledge of benefits which will be added by additional investment, in other words, marginal values. Dodge and Stager define shortage in analogous terms:

> A "shortage" of a particular type of skill may be defined to exist whenever the economic return on [additional] investment and the training necessary to acquire that skill is greater than the average return on an equally risky investment elsewhere in the economy.[46]

The "state of the art" in measuring output values falls short of meeting either type of information need in a manner that would be operational at the institutional level. The literature contains at least four distinct approaches to evaluating the outputs of graduate education:

1. Assessing the quality of inputs.
2. Estimating the marginal value of degrees at current output levels on the basis of private monetary income differentials.
3. Measuring private demand or, in other words, the marginal private value of degrees with respect to varying output levels.
4. Examining the relationship between higher education and economic growth.

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[45]Exactly the same information might also be expressed by comparing the average value and the average cost.

[46]Dodge and Stager [93].

The remainder of this section discusses these techniques and gives examples of each.

Input-Oriented Studies

One approach which has been taken to evaluate graduate degrees is qualitative ranking of various aspects of inputs into the training process on the basis of both subjective and objective information. Different groups of inputs are analyzed by comparison with similar inputs outside of the organization. The performance of individual inputs may, however, be measured on the basis of intermediate outputs such as jobs done, number of students taught, and so on.[47] Studies such as these, which are used as substitutes for actual benefit measurement, basically rely on cost information.[48] In fact, the appraisal of teaching in such terms has become a fairly well-developed branch of institutional research.[49]

Comparative studies of graduate education have been done.[50] The Cartter Report attempted widespread comparison of graduate departments within disciplines.[51] In it the author used a weighted average of several kinds of information to determine ranks.[52] A similar study, the Roose-Andersen

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[47]This principle is a standard one for organizational review. See, for example: Heyel [146], Papp [234], and Wasserman [325].

[48]General discussions of organizational evaluation in institutions of higher education can be found in the following sources: Arlt and Bent [14], Cook [77], Cook [78], Eckaus [99], Hallak [131], Keller [172], Woodhall and Blaug [345], and Zook and Haggerty [350].

[49]See, for example, the following sources: Alkin [6], Dwyer [98], Florida Board of Control [110], and Gage [118].

[50]A study in 1945 by Ernest V. Hollis, [154], discussed qualitative aspects of graduate education but did not attempt to evaluate current programs. The earliest such study known to the authors is a survey conducted in September 1957 by Professor Hayward Keniston of the University of Pennsylvania. Keniston's results were not published but, apparently, were circulated on an informal basis. The study is referred to briefly in "Graduate Programs Rated High in National Study," [123].

[51]Cartter [62].

[52]For one critique of the Cartter Report, see Magown [197].

Report, has been completed recently which updates the findings of the Cartter Report.[53] If there is a correlation between the measures of quality used in such studies and the value of graduate level training, then such studies can be used to rank the training output at different schools within disciplines. However, at least one source is skeptical of the traditional indices of institutional quality as being correlated with undergraduate achievement.[54] Even with the accurate measures of quality, however, reports such as the Cartter and Roose-Andersen Reports do not allow comparison of degrees from different disciplines.

Studies of the Marginal Value of Current Output Levels

Attempts to place monetary values on the benefits of graduate education do exist and the literature appears to be growing constantly. The most common type of study attempts to measure a single point on the schedule relating marginal benefits of graduate education to output levels, that point which corresponds to the current level of degree production.

Such studies do not attempt to measure the value of outputs jointly produced with the degree, nor do they attempt to measure benefits which are not reflected in the earning power of the individual degree recipient. For example, consumption benefits generated by graduate education and the intangible social benefits which are not measured by the additional taxes generated are typically not included. According to Dodge and Stager:

> The basic criticism of cost-benefit analysis of educational spending, namely that external and personal non-monetary benefits are not specifically taken into account, is most germane at the graduate level.[55]

Where consumption value is concerned, the existence of such benefits is recognized, but to date we are not aware of any studies attempting to measure

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[53]Roose and Andersen [251].

[54]Astin [20].

[55]Dodge and Stager [93], p. 24.

the value of this component for graduate education.[56]

Concerning the social benefits of degree output, the "state of the art" of measurement is likewise crude. Musgrave has in a more general context warned against

> . . . allowing personal value judgments to masquerade as objective propositions or potentially quantifiable magnitudes.[57]

Wiseman has suggested that the lack of agreement on measurement and evaluation of social benefits means that the awareness of such social benefits alone sheds little light on the problems of educational policy.[58] Breneman describes the situation in stronger terms:

> . . . vague references to improvements in quality and to social benefits are not persuasive in the skeptical atmosphere of today.[59]

Although investigation of the consumption and external social benefits of graduate education are not included in the calculations of added earning power, the portion of the increment in earnings which becomes state or federal tax represents at least a lower bound for the measurement of social benefits associated with degree output. The remaining personal income (i.e., net of taxes) similarly represents a lower-bound estimate of the private benefits of graduate education to which would be added the value of consumption and other intangible benefits. However, for a number of reasons,statistical techniques which are actually used cannot yield accurate values for even these lower bounds for the sum of private and public benefits.

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[56]For a discussion of the problem see Wiseman [342], p. 5. The author suggests a procedure to evaluate psychic returns by comparing total monetary return to education with money returns to investment in other assets and imputing the difference to psychic returns achieved from education.

[57]Musgrave [211], pp. 13-15.

[58]Wiseman, _op. cit._

[59]Breneman and Weathersby [48], p. 3.

There are at least six problems associated with earnings studies. These include:

1. There is currently no way to distinguish in any general way the extent to which they are due to innate ability, or to screening by employers.
2. Time profiles of earnings derived from cross-sectional data do not account for economic growth that will occur in the future.
3. Monopsony elements in the labor market mean private earnings will yield an understatement of productivity.
4. Earnings information derived from employment in enterprises which are specifically non-profit will yield an over-statement of productivity.
5. Earnings differentials include the cost of mobility between sectors or between regions, which is not a measure of productivity.
6. Earnings differential studies do not indicate total productivity of all degrees produced, but only the productivity of the marginal degree.

Without an independent measure of the value of output, value added by graduate education can only be estimated.[60] The six problems mentioned here are sources of bias in the estimations and are elaborated in the following paragraphs.[61]

1. There is no way to distinguish the extent to which earnings differentials are due to education and the extent to which they are due to innate ability.

The measurement technique typically employed compares earnings of graduate-trained individuals with earnings of those without graduate training. If individuals who go on to do graduate work are in any way more innately capable than those who do not, then only part of the earnings differential can be attributed to the training. The remainder is due to an innate

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[60]Brown [50].

[61]An excellent summary of these problems and a specific discussion of the biases they caused in estimating the returns to education is contained in Taubman and Wales [287].

difference in ability.[62] According to Roger Bolton, the first question raised by data on earnings differentials is:

> Do the data show that educated people earn more because of their education, or only that they possess certain natural abilities and motivation which explain both greater educational attainment and higher earnings? Does education really make that much difference?[63]

Clearly, what is needed is some measure of ability for every observed earning differential. However, since most observations consist of reported census information, there is no way at present to match available measures of ability with observed earning differentials on a large scale.[64]

Taubman and Wales have hypothesized another source of bias in the use of education credentials as a screening device by employers. Since employers may feel that there is a high correlation between educational attainment and on-the-job performance, educational credentials may serve as a license by means of which employers systematically screen out employment applicants with low educational attainment. If, say the authors of this hypothesis, screening will result in exclusion of some persons who do have the capability to meet employment requirements, then:

> . . . the returns to education arise primarily from an income redistribution due to a lack of entry and not to increases in skills . . . [and] . . . returns to society from educational programs will be over-estimated by conventional measures.[65]

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[62]This point has been raised by: Ashenfelters and Mooney [17], Clements [74], Danière and Mechling [87], and Dodge and Stager [93], p. 9.

[63]Bolton [36], p. 30.

[64]In a small sample study Robert Berls concludes that ability is somewhat more important than socio-economic status in determining entrance to graduate school. See Berls [28], p. 109. See also Panos and Astin [232]. Small sample studies have also been done by Wolfle and Smith [344]; also by Thorndike and Hagen [294], using a sample of 10,000 men who had been through a battery of Air Force tests in 1943, together with information on education, income in 1955, and family background. Data from the latter study, along with a re-survey of the original participants have been used by Taubman and Wales [287].

[65]Taubman and Wales, op. cit., Chapter 6, p. 1.

2. Time profiles of earnings derived from cross-sectional data do not account for economic growth that will occur in the future.

The second problem concerns the manner in which earnings profiles are compiled. Typically, census data or other information on mean salaries at a single point in time are used in order to determine salaries appropriate for given levels of training for each discipline, and given levels of experience. Then, for each level of training and discipline or discipline grouping a profile of the way in which salaries vary with years of experience is generated. The assumption is made that this profile is a reasonable estimate of the lifetime earnings which currently trained students can expect. However, this may not be the case for two reasons. In the first place, general economic growth may increase the absolute level of productivity of training in the future.[66] In the second place, preferences may change or technical innovations which provide substitutes for trained manpower may occur which change the price of such manpower relative to the prices of other goods, either positively or negatively. Dodge and Stager, for example, point out that since public sector demand for graduate trainees is falling off, estimates of returns to graduate training made on the basis of 1966-67 earnings data will be over-estimates of the true returns.[67]

3. Monopsony elements in the labor market means private earnings will yield an understatement of productivity.

A third problem occurs where there is a single buyer for individuals with a given type of training. It is a well-known result of economic theory that where there is no competition among buyers there is a possibility that the wage paid to individuals will be less than their contribution to productivity. According to Dodge and Stager there is some correlation between employment of scientists and engineers and the concentration ratios (which measure the degree to which one or a few

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[66] Dodge and Stager [93], p. 3.

[67] Ibid., p. 8.

firms dominate) in industry.[68]

4. Earnings information derived from employment in enterprises which are specifically non-profit may yield an over-statement of productivity.

It is also possible, where profit is not the motivation of the employing firm, that earnings will not represent productivity. In institutions which are specifically non-profit oriented and whose object may be stated as one of producing as much as possible subject only to not making a loss, wages will tend to overstate marginal productivity. This point does not appear to be mentioned in the literature; it can be demonstrated, however.[69]

5. Earnings differentials include the cost of mobility between sectors or between regions, which is not a measure of productivity.

A fifth problem is not so damaging where use of nationally aggregated data is concerned, but does affect use of sectoral or regional information. To the extent that there are barriers or costs involved in moving between sectors or between regions, these costs will be reflected in earnings differentials. To the extent that employment of graduate-trained manpower is predominant in one region or sector while employment of untrained manpower is predominant in another, the costs of mobility or re-tooling will appear in the earnings differentials attributed to training. Since such costs are not a measure of productivity, they should

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[68] Dodge and Stager [93], p. 4. The point is attributed to Scherer [265], p. 30; and also to Arrow and Kapron in Section 5 of [16].

[69] For the profit maximizing firm factors of production are hired to the point where wage equals marginal value product. In the non-profit organization where objectives may be described as maximizing output subject to a no-loss constraint, whatever profits or rents could be made are dissipated by producing at levels which require use of factors to the point where wage is equal to average value product. If the firm is producing in the area of diminishing returns and if the production function is not one where marginal and average product are everywhere equal, average value product and therefore wage will be greater than marginal value product.

be corrected for.[70]

6. Such studies do not indicate total productivity of all degrees produced, but only the productivity of the marginal degree.

If there is any slope to the schedule of benefits added by graduate training, then observed market earnings will reflect only the additional social value of the last unit produced. In other words, market wages represent productivity at the margin only. In order to know what the total benefit of a given level of graduate education outputs is, one must know the shape of the schedule which relates marginal output values to output levels or, in other words, the demand schedule.

There appears to be a general awareness of these problems at all levels in higher education, but two different reactions can be distinguished. The first reaction argues that such problems invalidate in advance the results of any attempt to evaluate the benefits of graduate education. Swanson, Arden and Still, for example, concluded in their report that it would be:

> . . .extremely difficult and even dangerous to try to relate a financial analysis to the products of an institution of higher learning when these products cannot be clearly defined, let alone given any sort of qualitative measure. . . [S]uch quantitative financial analyses are dangerous and useless because they imply that quality can be measured in such terms.[71]

Other authors have concluded that further research along the lines of social rates of return to investment in higher education, generally, is unwarranted because the method is suspect.[72]

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[70] Welch [333], p. 3:
. . . quality differentials are reflected in differential returns, but the differences in returns must be adjusted for differences in marginal products.

[71] Swanson, Arden, and Still [284], p. 27.

[72] Wilkinson in [335], p. 24, says, for example:
. . . one can use the social rates of return analysis to prove anything one wants to. To justify more educational spending, one can add in more non-monetary benefits or assume any portion of the total outlays will be investment. . . . Any technique of economic analysis which can be twisted in such a fashion to justify whatever action one wishes to take should be suspect.

Counter to this attitude appears to be the notion that some numbers are better than none:

> Whether the decision-making process is professional or political, the decision-makers need to have some standards of achievement to see whether a state is fulfilling its objectives.[73]

Another source expresses the opinion that dismissing the available calculations completely is just as harmful as accepting them without appropriate caution.[74] At least one author has recognized the conflict and recommended further interdisciplinary research to resolve it.[75]

Problems and warnings notwithstanding, estimates have been made of the value of graduate education benefits. Studies which have estimated the marginal value of graduate education outputs have all been directed at estimating social or private rates of return to investment in graduate degrees. Consequently, such studies yield only the rate of return on the marginal degree, not the average rate of return on investment in graduate education. As pointed out in the conceptual discussion above, the marginal rate of return will understate the average rate of return as long as there are diminishing returns in graduate education.

Marginal value studies all use cross-sectional estimates of earnings differentials in order to calculate the benefits.[76] The distinction between private and social rate of return typically refers not to a difference

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[73]Bowker [39], p. 1.

[74]Dodge and Stager [93], p. 24.

[75]Wiseman [342], p. 3. An economist himself, he takes his colleagues to task for ignoring this need. They do show an awareness of inadequacies of the results they are about to present. They are, the author adds, aware that their numbers, incomplete as they may be, will often be accepted as complete figures with the caveats becoming lost in the process; but they consistently "pass the buck" for remedying these inadequacies to somebody else.

[76]Welch [333], p. 7:

> By subtracting the expected income of a person who has not attended school from the expected income of someone who has, an estimate of the return to the second person's education is obtained.

Appendix 2-B at the end of this chapter contains a partial list of sources of earnings data.

on the benefit side (except for whether or not taxes are included) but to a difference on the cost side (i.e., whether or not student opportunity costs or subsidies are included). Studies which have calculated earnings differentials for graduate education have been done by Ashenfelter and Mooney, Butter, Hanoch, Hunt, and Rogers for the United States and Dodge and Stager for Canada.[77] All of these sources have estimates of actual earnings by degree and age. Dodge and Stager have estimates for Master's Degree in Chemistry, Physics, Mathematics, Business Administration, and Engineering, and for the Doctorate in Chemistry, Physics, Mathematics and Engineering. For all of these there are separate estimates on both public and private sector earnings.[78]

The source for Irene Butter's data is the National Science Foundation's *National Register of Scientific and Technical Personnel*, 1964. Butter computes lifetime salary profiles (ages 28-65) from this source for Physics, Zoology, Sociology, and English (the data for Linguistics is substituted for English, which is not listed in the NSF *National Register*). From the National Science Foundation data Butter derives salary growth rates; then she assumes starting salaries and applies these growth rates to them in order to calculate earning profiles for both Bachelor and Ph.D. degree holders in the four fields mentioned. The differentials for each year are then calculated and discounted to the present in order to determine a present value figure.[79]

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[77] Ashenfelters and Mooney [18], Butter [53], Hanoch [137], Hunt [161], and Rogers [250]. A comparison of these studies and studies of returns to undergraduate education for both the United States and Canada is given in Dodge and Stager [93], p. 22.

[78] Dodge and Stager [93], Tables A-6, A-7, and A-8, pp. 40-2. The same source has earnings for Chemistry, Physics, Mathematics and Engineering for the Bachelor's Degree. Another source by Stager [276], Table V, P. 32, has net present value of earnings differentials for 16 disciplines at the undergraduate level.

[79] Butter [53], pp. 57-64. Butter also uses alternative methods for determining salary differentials, some more sophisticated than others. For example, she calculates a median annual salary of terminal Bachelor's and Ph.D.'s irrespective of age and years of experience, pp. 59 & 61. A complete discussion of shortcomings in the data used and minipulations which were necessary before computing earnings differentials is found in Butter [53], Chapter 6, "Rates of Return."

Studies of the Relationship Between Marginal Values and Output Levels: Demand Studies

A "demand study" is, in the economic sense, an estimate of the relationship between the number of degrees produced and the social value associated with each additional degree. However, the term "demand study" is also used rather loosely in the literature and it is important to distinguish its other uses from the economic sense of the term. Other types of study for which the term may be used are perhaps more aptly described as: (1) manpower need studies and (2) enrollment projections. In both manpower and enrollment forecasting studies the objective is not to determine the manner in which values change with changes in the level of output, but instead to determine, on the basis of current prices, relative productivity levels, and from the past growth rates what the future needs of an area for trained manpower or for educational facilities will be. Both types of study differ from the true demand study in the sense that they take relative values as parameters and forecast on the basis of growth rates. It is the objective of an economic demand study, on the other hand, to determine the relationship between degree output and relative values at a point in time with other things assumed constant.

It is recognized that demand for education on the part of private individuals is positively correlated with income, family size, social and economic background, probability of success, and characteristics of the university. It is negatively correlated with the tuition, and monetary and non-monetary opportunity costs of attending school.[80] However, while all of these factors are factors in the demand for education they are seldom taken into account at the same time in any single study.[81] For the most

[80]Black [31], p. 2. Balderston shows that in cases of loan-financed education, demand is negatively correlated with both the shortness of the re-payment period and the closeness of the re-payment period to graduation. See Balderston [23]. Also, in a recent survey, Tucker and Sloan [299] found that 43 per cent of the respondents named financial assistance as the most important single factor influencing selection of graduate schools, with 56 per cent singling it out as the deciding factor in whether or not to attend a given graduate school.

[81]One report has listed characteristics of full- and part-time enrolled graduate students in terms of social background, family income, stipends, and demonstrations of previous educational capability. See National Center for Educational Statistics [215].

part this appears to be due to the limitations on the availability of suitable data.

While aggregate data may be used to determine the simple relationship between quantity (number of degrees demanded) and price to students (the tuition plus foregone earnings), such data cannot be used to determine such information as the income, social background, expectation of success, or other factors which might influence the value of degrees to individuals. Some studies have been done which attempt to investigate these latter elements on the basis of specialized sampling techniques and surveys.[82] Furthermore, the same limitations on point estimates of the social value of education apply to demand studies. Point estimates, even those based on pre-tax earning figures, may understate the true social value of increments in degree output. The same remarks are applicable to demand studies which are based on observed price-quantity relationships, where "price" consists of the sum of tuition and private foregone earnings. It might be possible, although no such attempt has been made, to use the per student subsidy provided by state, federal, and private sources of funds to determine social demand for graduate training. However, any study which uses such information is open to the criticism that educational subsidies are intended to cover costs and not to be a measure of value. Nevertheless, to the extent that funders are <u>willing to pay</u> these costs, the willingness to pay itself can be interpreted as a measure of the minimum value seen by the funders. A number of demand studies have been done, although to date only a few deal exclusively or specifically with demand for graduate education.[83] Apparently, much empirical work on the subject remains to be done.

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[82] Allan Cartter and Robert Farrell [64] have used statistical techniques and aggregate information in order to determine the effect of the draft on enrollments. One source also has investigated the effect of the timing of loan repayment on education demand: Balderston [23].

[83] A related type of study examines the characteristics of prices and quantities under assumptions of market equilibrium. See, for example, Folger [113]. The following sources have been selected as representative of the type of work which has been done so far: Campbell and Siegel [58], Eliff [100], Galper and Dunn [119], Schaafsma [261], and Tan [286]. The studies cited vary considerably in the time period, approach, variables included, and degree of aggregation. However, among them, the "state of the art" is well represented in terms of measuring the relationship between degree output and incremental values associated with degree outputs.

Manpower need forecast studies which include forecasts for graduate training needs appear to be more common in the literature. Perhaps because these studies involve the measure of past growth rates and relative price levels, such studies are more operational and their results less questionable than the true demand study. At any rate, much more operational use appears to have been made of manpower forecast studies, both at the university level and on a broader scale. The techniques for forecasting manpower needs are relatively simple in theory but the variety and complexity of inter-industry relationships make application of these techniques on a broad scale time consuming.

Conceptual application of these techniques to higher education has been made by Correa and Tinbergen, Bowles, and Honda, among others, in the form of forecasting models.[84] Models such as these have been employed for planning purposes, both in national and state projections. On the national level, studies have been and are continually done by the U. S. Department of Labor and the Bureau of Labor Statistics.[85] Among the non-agency studies are those by Blank and Stigler, the National Education Association, Bowman, and Porter.[86] Some studies have been done at the state level, most often in California.[87]

In addition to the forecasts on the output side of graduate education, some attention has been paid to forecasting of enrollments.[88] Like manpower need forecasts, enrollment forecasts project quantities on the

[84] Correa and Tinbergen [82], Bowles [40], Honda [155], and Honda [156]. See also Bolt, Koltun, and Levine [35]; and Pant [233].

[85] U. S. Department of Labor [309]. Current employment levels are also given in U. S. Bureau of Labor Statistics [301]. See also, National Science Foundation [224].

[86] Blank and Stigler [33]; Bowman [42]; Folger, Astin, and Bayer [114]; National Education Association [220]; and Porter [241].

[87] Adkins [4], California Department of Human Resources Development [56], Joint Staff for Liaison Committee [167], Marshall and Oliver [199], and Sanderson [259].

[88] Lins [193]; Marshall, Oliver, and Suslow [200]; Oliver [229]; and Spuck [273].

basis of current price and growth information and should be kept distinct from demand studies.

Students Relating Education to Economic Growth

The last type of study which evaluates the benefits of graduate education attempts to isolate the contribution of education to growth in national income. Typically, such studies involve first a specification of the variables which contribute to national income, including education; second, specification of the particular form of the relationship between national income in these variables; and third, use of multiple regression analysis in order to isolate the contribution made by each of the variables to economic growth. It should be pointed out that a major shortcoming of the statistical technique used is that correlation, not causality, is what is being measured. Actual contribution to national income due to education can only be inferred from results of such studies. The use of such techniques to determine the manner in which educational outputs have contributed to national income over time may be explained in terms of the single period demand analysis. The demand study, as described above, gives the value added to society by each increment in output, other things being held constant. The sum of all of these increments or, technically, the integral of the demand function, gives the total value of the actual level of outputs at a point in time. Studies which relate growth in national income to growth in education output attempt to measure value added taking account of all secondary changes which may take place.

A fairly comprehensive review of recent studies of this type by Denison and Becker is given in an unpublished paper by Harman.[89] An early study which uses simple correlation to find the economic value of education found a positive relationship between the percentage of income spent on public education in American states and per capita state income through the period 1890-1946.[90] However, the analysis is conducted for groups of states rather than for individual states. More recent studies by Bowman,

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[89]Harman [140]. The sources discussed by Harman are the following: Becker [26], and Denison [90].

[90]Bowyer [45].

Anderson and Denison explore more sophisticated techniques,[91] and Bowman has surveyed the techniques involved in such studies.[92]

Conclusion

To summarize, the "state of the art" with respect to evaluating benefits of graduate education is crude. In terms of the concepts outlined above, rough estimates only are available for a single point on the schedule of marginal benefit. However, since these are calculated exclusively from earnings differentials they include only the monetary benefits and none of the intangible benefits. In terms of earnings differentials attributable to training in specific disciplines, at the most seven individual disciplines have been investigated, and only four in the United States.[93] Furthermore, because of the limitations which have been described on the applicability of earnings differentials for purposes of measuring productivity, or even the source of those earnings differentials themselves, it is clear that little benefit information of operational value to policy-makers and educational planners is available to date.

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[91] Bowman [44], Anderson and Bowman [10], and Denison, [90].

[92] Bowman [43].

[93] Butter [53], for the U. S.: Physics, Zoology, Sociology, and English; Dodge and Stager [93], for Canada: (Doctorates) Chemistry, Physics, Mathematics, and Engineering--(Masters) Chemistry, Physics, Mathematics, Engineering, and Business Administration. Ashenfelters and Mooney [18] compute differential earnings for different degree program lengths, but only for discipline groupings.

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Appendix 2-C

SOURCES OF EARNINGS DATA

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CHAPTER 3

COSTING HIGHER EDUCATION OUTPUTS: CONCEPTUAL PROBLEMS AND ALTERNATIVE APPROACHES

Introduction

In the economic sense a cost is a benefit foregone.[1] The cost to society of using a resource is its most valuable alternative employment. Any resource with alternative uses which is committed to the production of higher education outputs is thus a component of the cost of producing those outputs. This chapter provides an overview of elements of the social cost of higher education outputs, with emphasis on elements of cost at institutions of higher education.

Like the benefits of graduate education outputs, the costs are not all borne through the institution of higher education. Table 3-I on the following page shows that the various outputs of graduate education involve costs borne directly by individual students and by society in general. Furthermore, the institutionally-related costs, that is, the costs of resources employed directly by the institution, are not the only significant parts of either the student or the social costs.[2]

The first section of this chapter summarizes the elements of total social cost and identifies elements of cost specific to institutions of higher education. In the second section, costs borne by private individuals are distinguished from those borne by the public at institutions of higher education. The third section illustrates the problem of relating institutional costs to outputs. The behavior of costs with respect to changes in output levels is discussed in the fourth section, along with the relevance of such

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[1] Fisher [109], p. 25.

[2] For a general discussion of educational costs, see the following sources: Bowman [41], Judy [168], Stigler [281], and Vaizey [319].

Table 3-I

COSTS OF GRADUATE EDUCATION

Student Costs	Social Costs
1. Earnings foregone by students during graduate education, less part-time employment income (after taxes)	1. Social income foregone during graduate education (taxes)
2. Out-of-pocket expenses a. Student supplies b. Differential living expenses and travel	2. Public and private financing of non-institutional costs (e.g., interest on capital grants; opportunity costs of land, including foregone property tax components in tax exempt situations)
3. Student financing of institutional costs (tuition and fees)	3. Public and private financing of institutional costs (costs not covered by tuition and fees)

information for various types of resource allocation decisions. The fifth section is a review of the literature on studies of costs at the institutional level in higher education.

Institutionally-Related Costs

Classification of costs by type of input is a useful way to organize cost information because it focuses on the resource components of dollar costs. Without intending our selection to be an endorsement of any single classification scheme, we have chosen the WICHE Object Classification system to outline object categories which represent resource use. This system has the virtue of brevity and at the same time contains a representative selection of data elements. It is shown below:

Salaries and Wages

Staff Benefits

Contract Services
(Internal and External)

Supplies

Travel

Equipment

Debt Service and Redemption

Land, Buildings, and Improvements

If elements in the list above are defined broadly enough, the list exhausts the inputs managed by institutions of higher education.

Unlike most higher education outputs, inputs are purchased in a market setting and consequently market prices can be found for them.[3] It should be mentioned, however, that market prices are not always an infallible measure of foregone benefits. They can diverge from the true opportunity cost if the market is imperfectly competitive. Richard Judy illustrates this point with the following example: If a professional association can

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[3]According to Millett [204], p. 51:
The only available common denominator for measuring these input resources is the use of a cost record: The dollar value placed upon man-hours of labor, upon the capital investment in facilities and equipment, upon the cost of supplies utilized in the productive process, and upon management.

restrict entry into the field of teaching by imposing certain hard-to-meet "licensing" requirements on prospective entrants into the field, it is possible that the teaching salary will reflect a surplus over the true opportunity costs of teaching manpower.[4]

Non-Institutional Elements of Total Social Cost

Every scarce resource has an opportunity cost. This is the value of the resource in its best available alternative use. If the resource is of a type that can be consumed in one accounting period, its opportunity cost may be equivalent to its market price.[5] If, on the other hand, the resource is an asset which yields benefits for more than one accounting period, its market price will be equivalent to the discounted sum of the opportunity cost of its services in each period of its expected life. Two important assets which are inputs into graduate education are human and physical capital. To some extent the opportunity costs of both types of asset are reflected in institutional expenditures. Wages and salaries, for example, represent compensation of labor services for opportunities foregone, while in some cases rental on physical assets represents similar compensation for the services of these assets.

In two important respects, however, opportunity costs of both human and physical capital are not reflected in costs at the institution. First, graduate students who forego alternative employment in order to undertake graduate education bear the sacrifice of earnings from the employment foregone. There are two components of the potential earnings sacrificed by students. The largest component, of course, is the personal or disposable income which remains after taxes. The second component is social or public in nature, the potential contribution to tax revenues which are foregone. The latter cost is borne by society as a whole. The second type of opportunity cost not reflected in costs at the institution relates to land and physical capital. Many forms of physical capital are employed by institutions of higher education. However, under capital budgeting systems

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[4]Judy [168], p. 11.

[5]Exceptions to this rule are discussed in the second section.

commonly used in higher education, the opportunity cost--either in the sense of interest on original cost or in the sense of current lease value--of these assets is often not taken into account.

Student Opportunity Costs

There is virtually complete agreement in the literature that time spent by students in the education process is an input. Roger Bolton cites as a major indirect cost of higher education the "labor earnings which a student must forego in order to devote himself to study."[6] Dodge and Stager urge that institutions "regard the student's time as a costly resource to be used effectively also."[7]

Estimates of the relative importance of the opportunity cost of students engaged in graduate study are not uncommon. Estimates on an annual basis range from $3,000 to as high as $10,000 for graduate education, but estimates are sensitive to field of study and method and time of estimation. The following table exemplifies some opportunity cost calculations.[8]

Table 3-II

OPPORTUNITY COST ESTIMATES
(1970 Dollars)

	Gross Annual Opportunity Costs (Potential Earnings from Full-Time Employment)	Less Average Annual Income Earned by Graduate Students	Net Annual Opportunity Costs
Physics	$8,700	$2,944	$5,806
Zoology	5,875	2,734	3,141
Sociology	8,250	2,624	5,626
English	7,375	2,759	4,616

[6] Bolton [36], p. 25.

[7] Dodge and Stager [93], p. 25. Similar comments are to be found in Butter [53], p. 51, and H.E.W. [308], p. 17. For discussions of various implications of student opportunity costs see the following sources: Hopkins [157], Langlois [189], and Mooney [208].

[8] The figures are taken from Irene Butter's 1966 study ([53], p. 27) and converted to 1970 dollars.

On a degree basis, Butter estimates that between 31 and 68 per cent of total social costs are represented by opportunity costs of the Ph.D. student. For the most part, actual estimates of opportunity cost which do appear in the literature are found in the context of rate of return studies. Consequently, Appendix 2-B may serve as a source of reference material in this regard.[9]

Criticisms which apply to the measurement of benefits on the basis of earnings differentials also apply to the measurement of student opportunity costs on the basis of earnings foregone.[10] For example, to the extent that those who undertake graduate education are in some sense more able than those who do not, foregone earnings estimates derived from census data may systematically understate the true opportunity cost of graduate students. Furthermore, market imperfections in the economic sectors from which the estimates are obtained may cause the actual earnings data to be a biased estimate of true labor productivity in those sectors.

There are other difficulties involved in measuring the opportunity cost of graduate students. Wiseman has pointed out that the opportunity cost of obtaining education "is not just foregone earnings, but the sum of this and foregone leisure, somehow valued in money."[11] He adds that since one of the outcomes of education is often likely to be a change in leisure preference, the value of opportunity costs is not constant for all types of education.[12]

At least one major demand study presents an alternative view and intentionally ignores opportunity costs as a component of price for the

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[9] An additional source is Wilson [339].

[10] See Chapter 2, pp. 61-70.

[11] Wiseman [342], p. 7.

[12] *Ibid*. This point is referenced in Machlup [196], p. 112.

educational output on the basis that the part-time jobs which college students use to support themselves are often indistinguishable from jobs which they are supposedly foregoing:

> Hence, an increase in such opportunities may well work to increase, as well as to decrease, demand.[13]

Problems such as these show that while there is a foregone earnings component in the total social costs of higher education, and of graduate education in particular, there is still no universally-accepted way of measuring this component.

Opportunity Costs of Physical Capital and Land

Opportunity costs of physical capital may be represented by either the annual lease value or the annual interest on the capital value, whichever is higher.[14] Construction or purchase of facilities by institutions of higher education is usually financed directly through the institutions by traditional sources of funds, industry or alumni donation, legislative appropriation, tuition, and fees. The interest foregone on the funds involved is usually borne directly by the funder himself and is not figured in the actual institutional capital budget. This, of course, may not be true in the case of bond-financed capital facilities; nor will it be true in the case of leased facilities. However, to the extent that capital is financed by direct capital grants, the interest cost of such grants is a social cost not reflected in institutional expenditures, making the problem of measuring and evaluating actual capital costs difficult. This problem is dealt with at some length in Chapter 4.

Land, of course, also has an opportunity cost in the potential earnings sense. Foregone returns to land may include both a public and private component. The private component is the total potential return less property taxes, and the public component is foregone property-tax revenue.

Other Non-Institutional Costs

In addition to the income foregone by students, there are out-of-pocket costs which must be borne as a result of graduate education. Outlays for instructional charges, books and supplies, and transportion are costs of

[13] Campbell and Siegel [57], p. 9.

[14] Judy [168].

graduate education, as are general living expenses, to the extent that they are greater than living expenses that would have been incurred had the student not entered graduate education.[15] It is important to note here that only the differential living costs associated with attending graduate school are costs of graduate education. Normal living expenses, it is assumed, must be borne regardless of what the student does. Therefore, attending graduate school imposes living expense costs only in the sense that living costs may be higher than otherwise.

Cost Allocation

The possibility that market prices do not reflect opportunity cost is only the beginning of problems involved in the costing of higher education outputs. This section deals with the essential problem of relating inputs to outputs. The crucial relationship between the production process and the allocation of cost to outputs is referred to. In particular, two problems are identified:

1. The measurement of costs associated with organizational units, or their direct costs; and
2. The allocation of the costs of organizational support units to the various primary outputs of the organization.

The following paragraphs outline the essential elements in these two fundamental problems. Since the remainder of this report is devoted almost exclusively to examining these problems in some detail with reference to graduate education, this section should be considered introductory to later discussions.

Measurement of Direct Costs

The term "direct cost" as used here means simply the sum of expenditures charged to any organizational unit. The intent is to measure actual expenditures, which may or may not be the same as those for which an organizational unit is budgeted. Associated with almost every object expenditure category there are unique problems of measurement. For example, the

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[15] Millett [204], p. 26.

traditional dichotomy between current and capital budgets has the effect that capital cost accounting often tends to focus on the creation of physical assets and not their period-by-period use by organizational units. Since most physical assets at institutions of higher education serve more than one organizational unit, it is not always easy to measure use. Furthermore, since the acquisition cost and the current opportunity cost of such assets may change over time, it is not always easy to evaluate use. Such problems are not restricted to capital budget items, however. A traditional feature of academic labor is that academic time is not exclusively devoted to activities in any one organization unit or, within organizational units, to a single function. Thus, the measurement of direct wage and salary costs is difficult also.

A more troublesome problem exists. Institutions of higher education are unlike commercial enterprises in the sense that sources of funds bear little relationship to the distribution of outputs. They do, however, resemble commercial enterprises in that financial management requires organizational orientation toward the source of funds. Financial management needs are perhaps a basic reason for the orientation of budgeting and accounting procedures in institutions of higher education toward source of funds rather than toward outputs. The result is that the organizational structure may bear little relation to the structure of output-producing activities and production processes within the institutions of higher education.[16]

With respect to this problem, Chapter 1 has mentioned the attempts to apply planning-programming-budgeting systems (PPBS) to higher education in an effort to re-orient the budgetary process to outputs. The American Council on Education has stated that the value of program budgeting "depends upon the establishment of meaningful relationships between projected programs and resources."[17] Appendix 3-A at the end of this chapter contains a representative list of sources dealing with program budgeting.

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[16] Firmin, et. al. [108], p. 37.

[17] A.C.E. [8], p. 156. See also Pinnell and Wacholder [240], pp. 91, 110, and 112 for summaries of the purposes of PPBS.

The intent here has been merely to raise questions concerning measurement of direct cost and not to attempt answers. In Chapter 4 attention is devoted to the principles of direct cost measurement, specifically in the area of measuring direct labor costs and direct capital costs. The point to be made here is that in attempting to trace resource use or costs through the higher education production process, problems arise even at the very first step--measuring direct costs of resource use in individual organizational units.

Allocating Costs

Direct cost measurement is only one part of costing higher education outputs. The next difficult problem is that of allocating direct costs of organizational units which provide support to the units in the final stages of the production process, that is, the academic departments. Simply put, the objective is to determine a means of allocating all costs or resources used to final outputs of the institution of higher education. The fundamental principle involved in costing outputs, then, is the principle of use or availability for use; but measurement of resource use requires an understanding of the production process itself.[18] In higher education this process is not a simple one. It rivals in complexity any industrial production process, both in the number and variety of outputs and in the number of stages in the process.

To begin to understand the production process one must understand the nature and disposition within the university system of all outputs of organizational units.[19] Suppose that each of the organizational units of an institution of higher education were completely independent of all others, and that each produced its own distinct type of output which were made available directly to clients and not used at all by other organizational

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[18]University of California [314], p. 94:
The really vital aspect of the production function concept is that it takes into account the quantities of factors needed for various quantities of product--in this case, for various numbers of students being exposed to the environment (which is, in a sense, various quantities of the environment).

[19]Firmin, et. al. [108], p. 15.

units. In such a case costing these outputs consists merely of measuring the total direct costs of each of the organizational units. The total cost of outputs produced by the first unit, for example, would simply be the sum of all expense objects used within that unit.

Indirect Costs

While every organizational unit within an institution of higher education does produce some output--a good, or, more likely, a service--it is clearly not true that all of these outputs are made available directly for use by clients. Some, of course, are. Academic departments may be viewed as representing the final stage in a process of producing training for both graduate and undergraduate students, as well as certain research and public service outputs. There are many other organizational units, however, whose outputs are never distributed directly to clients, but are used rather as inputs by units which appear at a later stage in the production process. Plant maintenance, for example, is a service provided to all units which occupy building space. Similarly, administrative offices, such as personnel, and budgeting and accounting offices, all provide services to other organizational units within the institution.

The fact that such units perform what may be considered a support role for later stages in the production process means that the outputs of supporting units are embodied in the outputs of units being supported. For this reason, direct costs of supporting units are sometimes referred to as "indirect costs" or "overhead" for the organizational units at the end of the production process.

Use of these terms is somewhat loose in the literature; it is therefore important that we distinguish the sense in which we use the term "indirect costs" from some of the other meanings associated with it. For the present purpose, the term "indirect cost" is primarily an organizational or institutional distinction. It refers simply to those costs of one organizational unit which may be associated with the production of outputs of another. It does not mean costs which are "fixed," i.e., do not vary with the level of output produced over some time span.[20] In other words, indirect costs may be either fixed or they may vary with output.

Clearly, it is the allocation of indirect costs to outputs which requires the most comprehensive knowledge of the production process. In order to allocate the costs of one organizational unit to another, the proportion of the supporting unit's output which the second unit uses as inputs must be known. Ideally, the outputs of all organizational units within the institution of higher education and the distribution of these outputs to other organizational units must be known. The implications of this requirement are significant. In the first place, cost analysis requires that some definition or measure of the goods or services provided by all organizational units be possible. In the second place, use of these goods or services by other units must either be monitored directly or approximated. A third consequence of the intimate relationship between production processes and cost allocation is that the allocation of costs cannot be done in piecemeal fashion.

In other words, cost allocation exercises must take account of all organizational units and all outputs produced. Omitting some outputs in the process of costing others may result in an overstatement of the costs associated with the latter outputs. For example, it is well known that graduate students provide services to undergraduate teaching programs. They also provide research services to faculty involved in research projects. An attempt to determine the costs of undergraduate teaching or the costs of research without reference to these interrelationships would introduce bias into the results. Consequently, in order to cost any of the outputs of higher education, the full production process must be studied; i.e., the costs of all outputs must be determined together.

In this light, a program budgeting system can offer two advantages over traditional accounting: first, by grouping activities in a manner

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[20] A significant portion of business accounting literature has been devoted to elaborating the distinctions between the "fixed/variable" and "direct/indirect" concepts of cost. See, for example: Anderson, Moyer, and Wyatt [12]; Bachofer [22]; Devine [92]; Foley [112]; Kelley [173]; Lindloff [192]; McMullen [201]; Parameswaran [235]; Sautter [260]; Schmidt [263]; Tingey [296]; Withey [343]; and Wright [346].

which focuses on the outputs they generate, it becomes much easier to use the budget accounting records for costing output; second, since the number of separate organizational units and consequently separate budgetary accounts at a typical American university ranges in the thousands, it is helpful for purposes of cost allocation exercises to aggregate like units according to the outputs they generate and according to the stage in production process at which they appear.[21] The reorientation of organizational accounts is therefore an important part of cost allocation.

The Joint Product Problem

It must be made clear at the outset that activity definition in the program budgeting sense is merely an attempt to regroup budgetary accounts in a manner which is more or less parallel to the production process. It is not and need not be an exact science. For purposes of costing, the important aspect of activity definition is that it makes the outputs of organizational units--and consequently resource use--easier to trace through the production process.

One of the advantages of program budgeting is that numerous activities which are homogeneous in the primary intent (of funders or clients) can be identified and aggregated into "programs." However, it must be made clear that while these aggregations rest on primary intent, each activity may have outputs or by-products which differ from those identified as being of primary intent. Such by-products to the extent that they are an <u>inevitable</u> result of producing any given output, are commonly called "joint products." The existence of joint products means that while program or activity definitions may coincide primarily with the outputs of activities, this coincidence is not <u>exclusive</u>. Program classification in the presence of joint products is doomed, then, to be an imperfect enterprise, but cost allocation is not necessarily hindered. Regardless of how a program or activity is defined, if the inputs and costs can be accurately measured, the accuracy of the ultimate cost allocation is dependent <u>only</u> on the degree to which outputs, and users of outputs, can be

[21] In Chapter 5 the WICHE Program Classification Structure is used as an example of such aggregations.

identified and values can be attached to the various output dimensions.

Much is said in the literature about the joint product problem in higher education.[22] The real reason why joint products are a problem for costing outputs is that information is required about the value and distribution of each output jointly produced. Cost analysis, after all, is the problem of relating values foregone to values gained through the commitment of resources in an effort to determine whether or not the commitment is worthwhile. The following example illustrates this point: Suppose it is known that one additional student credit hour costs exactly $8 to produce. If it is known that the market price or true value of that student credit hour is $10, then we say that the cost of each dollar realized by the production of student credit hours is $.80. Furthermore, this figure may be compared with the cost of dollars generated by other producing activities, for example, research and public service. Such information provides a means for determining the best way to allocate resources.

Suppose next that the activity above which produces student credit hours also produces some joint product in a fixed proportion to student credit hours. The joint product might be a public good of some sort, for example, a scientific demonstration or cultural event made available to the university community or the public at large. If the value of this joint product is also capable of measurement and turns out to be $5, then the total value of outputs generated by the activity in question would be $15. Given the $8 cost figure previously mentioned, the cost of a dollar's worth of output from this activity would be roughly $.55. In order to go beyond this

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[22] Judy [168], p. 17: "Most attempts to allocate university costs to programs founder on the problems of joint products." The problem is, of course, not unique to higher education. The existence of inputs which yield multiple outputs has been blamed for the "inability on the part of most manufacturing firms to determine the effectiveness of indirect employees." See Foley [112], p. 19. The joint product problem led the California and Western Cost and Statistical Study to conclude pessimistically that:

> Any cost figures developed from a production process in which joint costs are involved are actually opinions rather than facts." (University of California [314], p. 30).

point and determine the "unit cost" of each of the two outputs, this cost-per-dollar figure would simply be multiplied by the respective unit values of each output. Thus, the unit cost of the student credit hour would be ten times $.55, or $5.50. Similarly, the cost of the other joint output would be $2.25.

The hypothetical example above illustrates what is the most troublesome aspect of the true joint product situation for the purpose of costing outputs. Measurement and evaluation of outputs is not always possible. However, it should be clear that the presence of joint products is not cause for despair, as long as there exists some method for obtaining reasonable estimates of output values. It is worth adding here that under certain circumstances even output values may be unnecessary. This is the case if, for any single activity, 100 per cent of the output--whether or not it consists of joint products--is used only by one organizational unit or by one client. Clearly, then, all the costs of the activity producing the outputs involved should be borne by the user of the activity outputs. In this case, there is no need to go further and to break up the direct costs of the activity, or to estimate separate output values--only the aggregate value is needed.

It is only when the output or outputs of an activity are consumed by more than one client that cost allocation becomes difficult. To the extent that separate clients mean separate sources of payment or subsidy, as in the case of higher education, costs must be separated to determine the amount of the subsidy from each. In this case and in the presence of true joint products, unit values and measures of output use are a *sine qua non* of precise cost allocation.

Cost Information Related to Decision-Making

There are many different ways to conceive of costs. It is essential, therefore, to determine first:

> . . . why or how specific cost information is to be used before we know which costs are relevant.[23]

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[23] Firmin, *et. al.* [108], p. 33.

This section identifies different types of cost information on a conceptual level, and discusses the appropriateness of each type for specific kinds of decisions.

The measurement of costs (benefits foregone) is most commonly stated in aggregates of average (unit) costs or of marginal costs.[24] As was pointed out in Chapter 1, these two measures are not equally useful in all decision-making situations if they differ systematically. When benefits foregone by resource committments are characterized by diminishing returns, marginal costs can be expected to increase as output levels increase. Under these conditions marginal and average costs will not be the same, even for large output levels. However, what is not obvious is whether, in fact, there is a significant difference between marginal and average costs for higher education outputs. The general consensus in the literature appears to be that there is.[25] If so, average costs will be inappropriate for decisions which require information in increments.

Decisions for which marginal and average cost information, together with marginal and average benefit information, are appropriate have been discussed previously in Chapter 1. For purposes of determining levels of output consistent with maximum effectiveness or resource use, it was concluded that information in increments is appropriate. According to Firmin, _et_. _al_., marginal analysis is useful for predicting costs that result from change in the section size, teaching load, administrative level, admissions, enrollment,

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[24]Weathersby in [326] defines marginal cost as:

> . . . the additions to the total system cost required to accommodate that particular activity, or alternatively the marginal costs of an activity are those resource costs which could be avoided if the activity were not undertaken . . .

While Weathersby describes marginal cost in terms of activities this does not appear entirely proper. It seems more appropriate to describe marginal cost in terms of outputs produced by activities, or at least activity "levels" defined in terms of output quantities.

[25]Hicks in [147], p. 22, is almost vehement on the point. He calls the notion that marginal and average costs are equal in higher education:

> . . . the myth of linearity; . . . for virtually any type of productive process the cost curve is curvilinear in in nature.

research, teaching proportions, maintenance, staff and organization.[26] As mentioned previously, however, average costs have more often been used for such purposes.[27]

Average costs are appropriate, however, for determining the amount of profit or loss (subsidy) associated with a given level of output,[28] but a number of criticisms can be raised against the misuse of unit cost information. One author has called average costs:

> . . . the most widespread fiction in existence. . . . It may be used to demonstrate extravagance or prove economy, though the facets behind it are the exact opposite of the conclusion it sustains.[29]

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[26] Firmin, et. al. [108], p. 61.

[27] Doi in [94], p. 184, for example, recommended use of workload and instructional cost studies for purposes of internal resource allocation. See Chapter 1 for other references on this point. In particular see: Department of Public Instruction [91]; Farrell and Anderson [107]; Miller [203]; Texas College and University System [290]; and Texas College and University System [291].

[28] According to Van Wijk and Levine in [321]:

> No formula financing scheme is intended to determine the internal resource allocation process of individual colleges. It must be clearly understood that the formula to be developed would only be intended to determine the amount of financial support each college is to receive from the Government. (p.22)

Bowen in [38] makes a rather subtle distinction between the use of average costs in determining appropriate charges on research grants and the use of marginal cost analysis to determine the "effect" of research on the university:

> One can argue quite consistently that allocating costs on a strict pro-rata basis is the fairest and most practical way of determining the charges that government agencies should pay, but that approach in cost behavior from an incremental viewpoint is the only way of appraising the actual short-run effects of such involvements on the finances of the university. (p.97)

[29] Brooks [49], p. 24.

In a somewhat milder tone, Hamelman has pointed out that:

> The interaction between institutional productivity, factor price increases, indirect educational support costs and other variables affecting unit instructional costs are not clearly evident from average cost data.[30]

Doi has referred to the fact that quality differences are often ignored in unit cost comparisons.[31] The Technical Committee on Costs of Higher Education in California has pointed out that such cost figures often become the only quantitative information which is available to laymen, and that the inability to interpret such information correctly leads to its misuse.[32] Finally, William Bowen has stated that the principle of averaging has probably resulted in net institutional costs for hosting federally-sponsored research.[33]

The net impression obtained from reviewing the recent literature concerning the use of average and marginal costs is that information in increments is by far the most valuable sort of information which can be made available to planners and decision-makers. However, it must be remembered that "increments" simply mean changes in the total. In other words, the only way to determine incremental costs is to observe total cost behavior over different output levels. As mentioned in Chapter 1, there is little difference in terms of informational content between the total and average cost associated with some given level of output. If anything, average cost is merely a shorthand representation of the total cost involved with the one level of output. The point is that average costs can be easily converted to total costs and that total costs must be calculated (over some output range) in order to determine true marginal costs. Consequently, while average cost information by itself is of limited value in determining optimal levels of output, the determination of total cost, including the allocation of full institutional costs, is a necessary first step in the

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[30] Hamelman [132], p. 7.

[31] Doi [94], p. 196.

[32] Technical Committee on Costs of Higher Education in California [288], p. 34.

[33] Bowen [38], p. 50.

estimation of real marginal costs.

The type of decision for which marginal cost information is appropriate is typically an ex ante decision concerning cost behavior over a range of output.[34] Since perfect foreknowledge is rare, one can only make an educated guess as to additional costs which will be incurred by additions to the level of output. Often the only material at hand to aid such guesswork is information about the costs of previous output levels, the historical costs.[35] While various statistical techniques are available to test the accuracy of predictive models in terms of generalizing the relationships underlying the production process, all such techniques must rely ultimately on historical total cost information.

Cost Studies in Higher Education

Cost analysis which is based on modeling of the higher education production process represents one of the most sophisticated branches of costing. However, costs can be and, of course, have been analyzed in far simpler terms. A "cost study" may be a simple description of the aggregate inputs at a point in time or over time or it may be a partial representation of cost behavior within organizational units. This section provides a summary of cost analysis studies with reference to specific examples in the literature. Studies are classified in five different categories: (1) simple input studies; (2) direct cost studies; (3) full cost studies; (4) generalized systems analysis studies; and (5) total systems analysis studies. It is hoped that the information provided will be useful for those interested knowing the current alternatives for costing in higher education.

A universal technique for managing analytical problems is "modeling." A model may be loosely described as any abstraction from

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[34]Alden [5], p. 6:
This is especially true when internal managers must evaluate various alternatives for initiating or expanding instructional programs.

[35]Hamelman [135], p. 5:
Unit cost data are more meaningful when they can be reviewed over a period of years and trends in cost behavior can be detected.

reality.[36] Where cost studies are concerned, models usually refer to symbolic representations of any or all aspects of the production process. Since the primary purpose of model building is to translate real relationships into a set of symbolic relationships susceptible of manipulation either by hand or with the aid of computers, some realism is always lost. It is the job of a cost analyst to determine the most appropriate degree of complexity for the particular task facing him.[37] The cost of absolute precision in cost analyses is high and in most cases is not worth the benefit expected. Consequently, a certain amount of accuracy must be sacrificed for the sake of computational manageability, bringing the costs of analytical projections in line with their value.

Although not always explicit, a model of some sort or other underlies virtually every type of cost analysis. For example, the use of average cost information in budgetary processes is implicitly based on the assumption that current unit cost estimates yield a reasonable proxy for costs added by additional units of output.[38] In algebraic terms the relationships underlying this assumption may be stated quite simply as:

$$TC(X_1) - TC(X_0) = (X_1 - X_0) \cdot AC(X_0),$$

where X_i are different output levels, $TC(X_i)$ are the total costs associated with each output level, and $AC(X_i)$ is average cost, and the expression on the left-hand side of the equation is marginal cost. It is important that such assumed relationships be made explicit. The importance of making known the implicit relationships embodied in analysis lies not so much in the fact that assumptions may be restrictive as in the fact that results may not be directly comparable with results of other models. Even if the ability of a relatively simple model to predict is good, its results can have but little credibility unless its use is made explicit.

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[36] Basically, a model is a mathematical representation of the relationships between outputs and inputs in a production process.

[37] For a thorough discussion of modeling for administrative decision making, see Wallhaus [324].

[38] It is this assumption that has been referred to by John W. Hicks as the "myth of linearity." See Hicks [147], p. 22.

The literature on cost analysis tends to emphasize the advantages of modeling. It affords the opportunity to modify and experiment with reality by means of a surrogate subject which allows the user to avoid tampering with the real subject.[39] But there is a trade-off between "complexity for realism and simplicity for user understanding and efficiency of computational time,"[40] and there is a risk that the model will be allowed to determine analytical objectives instead of vice versa.[41] Nevertheless, in a situation where controlled experimentation with the real subject is impracticable, models do provide an alternative.

Simple Input Studies

One type of cost analysis which is not uncommon consists simply of a report on any or all elements of total expenditures by institutions of higher education. Reports might be in terms of a single aggregate dollar value for one or more institutions,[42] or a report by object classification of total expenditures. The purposes of such reports are usually to indicate the order of magnitude of overall educational budgets and to determine the time patterns and shares of the various objects of expenditures. A recent study of ten southern universities, for example, observed that the single most important cost element in the schools studied was the item, wages and salaries.[43] Another study has observed increases over time in the relative

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[39] Alden [5], p. 10.

[40] *Ibid.*, p. 14.

[41] Quade [244], p. 10:
Most flaws are caused by such pitfalls as emphasis on working with the model instead of the question, or concentration on the type of uncertainty that can be treated analytically by Monte Carlo or other statistical techniques rather than on the real uncertainties, or neglect of the subjective elements in the analysis.

[42] See, for example, O'Neill [230].

[43] Firmin, *et*. *al*. [108], p. 105.

shares of administrative personnel.[44]

For the most part, such studies do not require analysis so much as they involve organization and aggregation of data from a wide variety of sources such as individual institutions, state and national budgets, federal agency reports, and so on.[45]

Direct Cost Studies

A direct cost study may focus on activities at different levels of aggregation. Typically, however, direct cost studies in higher education focus on those units in the last stages of the production process, academic departments. Direct cost studies in higher education are not necessarily total direct cost studies. A great deal of attention, for example, has been devoted to only the faculty salary cost portion, typically called "faculty salary" studies. "Instructional cost studies," on the other hand, generally include items such as departmental overhead, supply costs, and non-academic staff costs.

Faculty salary and instructional cost studies may or may not be presented in terms of averages, although average cost studies are the most frequent. Commonly-used output measures are student contact hour or clock hour, which takes account of classroom time, and student credit hour, which does not. In the more than 50 years during which unit cost studies have been undertaken, the student credit hour appears to be the most popular output measure. Tindall and Barnes, in fact, conclude that the student credit hour is the best available index of output of the teaching function, even though it may be less than perfect. Another common technique in measuring

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[44] O'Neill [230], Chapter 3, "Expenditure on Input," Tables 9 and 10. O'Neill shows that from 1930 to 1967 expenditures on general administration went from 6.8 to 9.0 per cent for public schools and 9.8 to 12.3 per cent for private schools.

[45] See also the following sources: A.C.E. [7]; Association of Collegiate Schools of Architecture [19]; Bowen [37]; Chandler [69]; Eurich, Kinney, and Tickton [102]; Grinter [124]; Hartman and the National Science Board [142]; National Center for Educational Statistics [216]; National Center for Educational Statistics [217]; Shawhan [267]; Southwick [272]; U. S. Congress [303]; U. S. Office of Education [310]; and U. S. Office of Education [311].

output for direct cost study purposes is to define a normal course load, say 20 or 30 student credit hours, and to use this measure in order to translate credit hour output into full-time equivalent student training output. The rationale here is typically that full-time equivalent student measures avoid the overstatement of productivity which results from using student head count in situations where part-time study may exist.

A number of authors have devoted attention to instructional cost studies. Among the most important contributions are those by John Dale Russell, Floyd W. Reeves and James I. Doi.[46] Before 1930 there was little standardization in the techniques used. However, in 1932, the National Committee on Standard Reports for Institutions of Higher Education began a comprehensive reivew of studies then in use. The result was a bulletin entitled *A Study of Methods Used in Unit Cost Studies in Higher Education*; a second volume entitled *Financial Reports for Colleges and Universities* was published in 1935.[47] In the 1950's, important contributions were made by Russell and Doi in twelve articles published in *College and University Business* under the title, "Analysis of Institutional Expenditures."[48] More recently, Russell has published "Budgetary Analysis."[49] For a list of instructional and faculty salary cost studies see Appendix 3-B.

The studies cited have been more or less exploratory in nature. In fact, different ways to analyze even the direct costs of instruction have developed almost at random. A review shows the variety of types of unit cost. For example, costs per student credit hour within a given discipline and given level of course offered can be used to generate a number of different unit-cost figures. They can be aggregated either across all levels within the discipline or across all disciplines for a given level in order to determine costs by level or by discipline. Furthermore, through a number of

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[46] Russell [254]; Reeves and Russell [248]; and Doi [94].

[47] Both of these studies are discussed in Kettler [177].

[48] Volumes 19 through 21, September 1955 through August 1956, *College and University Business*.

[49] Published in Axt and Sprague [21], pp. 101-53.

different manipulations, they can be used to generate costs per student credit hour by level and discipline of student or by level and discipline of course offered.[50] A combination of these two types of information can be expressed by aggregating costs of all courses within a discipline according to the level of students taking the course in order to determine costs by level of student and discipline of course offered.[51]

Until recently there has been no attempt to bring all of these various types of information together in order to compare their components. However, two very useful studies have become available which provide a convenient framework for summarizing and comparing the various types of unit cost information used in faculty salary or instructional cost studies. A recent paper by Gulko has expressed these unit costs in terms of simple algebraic symbols and used this symbolic language to derive expressions for most of the types of unit cost information currently in use.[52] This same source describes a procedure for determining actual direct costs associated with degree output.[53]

A second recent contribution, which provides an important means of relating the various cost elements and presenting them in a comprehensive framework, has been made by Paul Hamelman.[54] Basically, Hamelman uses an

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[50]According to Kettler [177], p. 204, classification by course level is most common:

> All costs might be classified according to the status of individual students but more usually according to level for which the course is primarily designed.

[51]Some examples of salary cost study methodologies are: Corrallo [81]; Hamelman [133]; Hamelman [135]; Hirschl [151]; and Reeves, Nelson, and Russell [247].

Some recent examples of instructional cost methodologies are: Hamelman [134]; Hamelman and Mazze [136]; Kettler [177]; and Terman [289].

[52]Gulko [127]. This draft does not have expressions for student credit hour costs by level and discipline (program) of student or for student credit hour cost by discipline of course offering and level of student enrolled. However, expressions of both of these elements can be easily derived using Gulko's terminology.

[53]*Ibid.*, Sections 3 and 4.

[54]Hamelman [133].

input/output framework with disciplines as the producers and degree programs or disciplines as the consumers in an input/output matrix. The matrix itself is simply a means of mapping credit hours produced into degree programs and has become an important part of enrollment forecasting and planning in institutions of higher education.[55]

The value of such studies varies with the particular type of unit cost which is used. It has been suggested by some that, given the current "state of the art" in determining full costs, instructional cost studies are the only type of cost study which provides any basis for interinstitutional or even interdepartmental comparisons. Instructional or simple faculty salary cost studies do not lose comparability depending on whether the institution provides room and board or just instruction, or whether it has a large or small athletic plant, and so on.[56] Direct unit cost studies are also valuable because they tend to indicate at a glance such factors as low enrollment or course demand, high percentage of senior faculty positions assigned to the department, substantial faculty salary increases over a period of time in a certain department, a high attrition rate in certain courses, etc.[57] Hamelman has described the advantages of the input/output matrices which relate various types of unit cost as follows:

> The advantage of instructional input-output matrices is that they display several dimensions of unit instructional costs. . . . No one of these measures is the "correct" or "best" method of displaying instructional costs; rather, each measure is useful for different kinds of planning and decision-making problems. Considered together, they provide more complete insight into educational systems.[58]

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[55] Typically, the matrix is used to derive the coefficients which express demand for departmental courses from students from other departments. See Hamelman [135], p. 7.

[56] Hughes [158].

[57] Morrell [210], p. 19.

[58] Hamelman [133], p. 4.

Full Cost Studies

Full cost studies are those which allocate the costs of organizational support units forward to the final outputs in the production process. The problems which must be faced in any such study have already been described as:

1. Definition of activities or programs at an institution of higher education.
2. Measurement of direct costs of activities.
3. Measurement or estimation of support activity outputs.
4. Measurement or estimation of the distribution of outputs among user activities and clients.
5. Allocation of costs on the basis of output use.

In the remainder of this report the activity and program definitions of the WICHE Program Classification Structure are utilized as a convenient example of how activities might be defined and organized into programs. The following chapter deals specifically with problems involved in the measurement of direct costs of both labor and capital inputs. Measurement and approximation of support activity outputs and estimation of their use in other activities is the subject of Chapter 5. Chapter 6 discusses full cost allocation procedures currently in use with particular reference to the implications of different procedures concerning the nature of production processes at institutions of higher education.

Aside from the computational problems involved in full cost studies, two observations can be made here. First, full cost studies, to be done accurately, require a thorough study of the production process. As a result, they are complex and time consuming and, therefore, expensive. As will be shown in Chapter 6, the fewer the simplifying assumptions which are placed on the nature of the production process, the more complicated the appropriate allocation procedure becomes.

In addition to the fact that cost allocation procedures vary in complexity and expense, it also appears to be recognized that they vary in terms of the results that they produce. As has been often observed:

> The differences in the cost figures which result from utilizing different procedures are surprisingly great.[59]

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[59] Miller [203], p. 96.

To date, however, there does not appear to have been any effort to test systematically and compare the results of the different procedures. Consequently, it is not possible to say whether the less expensive and simpler procedures result in significant biases or not. Since the difference in expense between different methodologies is significant, it would be worthwhile to see whether any appreciable improvement in results is gained by additional expense on full cost studies.[60]

Simple Systems Studies

An alternative to the actual computation of the direct or full costs of outputs of institutions of higher education is the application of simple statistical techniques to information on aggregate inputs and aggregate outputs. Instead of a detailed investigation into every step in the production process, a simple algebraic relationship between inputs and outputs is hypothesized, usually on the basis of experience and judgment. Then, using the technique of multiple regression analysis, the algebraic formulation or model is "tested" by fitting it to the data. A model which yields a good fit is one which, together with the explanatory variables for which it is defined or specified, can explain a high percentage of the variation in the independent variable. A model which does yield a good fit simultaneously yields estimates of parameters which quantify the actual relationships between outputs and inputs.

Fundamentally, there are two ways to state the relationship between outputs and inputs. The relationship can be expressed as a cost function or as a production function. A cost function is one which explains variations in cost on the basis of changes in output level. Suppose "s" represents total expenditures and $x_1, \ldots x_n$ represent outputs. Then a cost function might be expressed in the unspecified form:

$$s = f(x_1, x_2, \ldots, x_n).$$

A production function, on the other hand, inverts the relationship. The outputs become the dependent variables and inputs the independent variables.

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[60]Two fairly complete summaries of cost studies used in higher education are Cavanaugh [66], and Gibson [120].

Let "x_i" represent total output of type "i" and $a_{i1}, a_{i2}, \ldots, a_{im}$ represent inputs or resources. Then, a general production function would be:

$$x_i = g(a_{i1}, a_{i2}, \ldots, a_{im})$$

Clearly, the two equations above are related. There are, of course, "n" different such simultaneous equations. In fact, however, the most common approach is to assume that certain outputs are similar enough to consider homogeneous. The resulting production function, where "q" represents total unit output, say in student credit hours, full-time equivalent students, or enrollments is then estimated:

$$q = g(a_1, a_2, \ldots, a_m).$$

Even in this simplified aggregate form, however, production functions are far less common than cost functions in the literature.

Cost studies based on a single equation model such as that described in general terms above also typically involve some simplification of outputs. It is not uncommon, for example, to find such cost studies based upon total enrollment.[61] Other studies have used student credit hours, differentiated by level, as the independent variables.[62]

The value of simple single equation models of resource use at institutions of higher education lies in the fact that they can give an idea of the behavior of total costs--and thus, parameter estimates for average and marginal costs--over different output ranges and they are relatively inexpensive and simple to use. The conclusion reached by authors of all such studies is that there is a significant difference between marginal and average cost in terms of either credit hours or enrollments.[63] Blumberg and Wing,

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[61]See, for example, Firmin, et. al. [108], Chapter 4. The authors use independent additive linear production functions with enrollment as the independent variable. See also H.E.W. [308], Chapter 4. Another example is Blumberg and Wing [34]. Non-sponsored expenditures is the dependent variable, and student count is the independent variable.

[62]See, for example, Gibson [120], and Stewart and Hartley [280].

[63]This bears out the caution made by Judy in [168]:

If we are costing an expansion or contraction of an existing program it is important not blithely to assume equality of average unit costs (AUC) and incremental costs (IC). . . . There may be considerable difference between AUC and IC. (p. 15) for example, found that in graduate medical programs cost curves are U-shaped.[64] That is, average costs decrease to a certain point as output rises, after which they rise with output levels. In an unpublished thesis, Thomas T. Gibson tested the explanatory power of cost curves for three levels.[65] The curves which tested well were all U-shaped. Gibson estimated marginal costs of lower-division, upper-division and graduate credit hour production of $19.03, $24.58, and $90.43, respectively (using 1967 data). However, he also found that while undergraduate average cost was rising, graduate average cost was falling. In other words, graduate credit hour production in Colorado at the time of Gibson's study was on the left-hand side of a hypothetical U-shaped average cost curve.[66]

Studies of cost behavior in engineering programs have been undertaken by Terman, who has also observed similar average cost behavior.[67] Terman identifies the minimum point on this curve in undergraduate engineering programs with three major fields as around 150 degrees per year. For Master's level programs he identified the minimum point as approximately 125 to 150 degrees per year. While the studies mentioned here have all observed a difference between marginal and average cost, they have been concerned with relatively small changes in output levels. At least one author has concluded that for large changes:

> . . . in terms of 100 more or 100 fewer students at any given institute, there may be little difference between marginal full cost and average full cost.[68]

Single equation cost and production function models of institutions of higher education naturally involve simplification. The point is, however, that they can be used to derive parameter estimates on the basis of which to

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[64]Blumberg and Wing [34].

[65]See Gibson [120[, p. 175, for average costs of graduate credit hour production.

[66]*Ibid*., p. V.

[67]Terman [289], p. 2.

[68]Mishan [206], p. 4.

forecast the results of future changes in the independent variables. The real test of a model lies in the validity of its predictions, not its assumptions.[69] As long as the relationships underlying the model are stable, its ability to predict well may be unrelated to the accuracy of its assumptions in a static sense.[70]

Single equation models are a substitute for more complicated ones which attempt more accurate measurement. To the extent that information on changes in disaggregated outputs or cost differences on the same basis are to be investigated, there may be no way of getting around a more complex cost allocation study. This would be the case if, for example, one wished to develop separate cost models for discipline groupings. In order to get the necessary data to fit such models, cost allocation would have to be carried out at least to the extent of allocating costs between disciplines. Again, to date, there has been no attempt to determine the effect of aggregation on a model's ability to predict. Testing of this sort would appear to be a fruitful exercise for those interested in cost analysis in higher education, simply to determine whether more complex models yield results which are worth the additional costs they entail.[71]

Complex Systems Studies

Single equation models of cost or production activity in institutions of higher education are limited by the degree of aggregation which they require. Results of such models are general and do not apply specifically to individual disciplines or levels. Furthermore, they are applicable only

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[69] See University of California [314], pp. 95-7, and Firmin, et. al. [108], p. 99.

[70] See Breneman [47] for a discussion of the stability of parameters used in faculty workload models in the University of California system.

[71] The following sources deal in a more or less technical fashion with problems involved in multiple regression analysis and fitting cost curves in particular: Bowles [40]; Clark [73]; Comiskey [76]; Gunders [128]; Kempster [175]; Lundberg [195]; Organisation for Economic Cooperation and Development [231]; Siegel [270]; Stewart and Hartley [280]; Troxel [298]; and H.E.W. [308].

to the production relationships in effect during periods which the data to which they are fit were generated, which means all inefficiencies of the existing production process are built into the model. Long range planning needs of higher education are often more sophisticated than this. Administrators need to know the result in terms of costs or, alternatively, resource requirements of changes in output levels, where outputs are differentiated by discipline and level. They also need to know what effect changes in organizational structure or other aspects which determine the nature of the production process will have. In order to respond to needs of such sophistication, sophisticated models which take more comprehensive account of the production process are necessary.

Models which consist of a number of simultaneous equations, each representing a different aspect in the production process, are commonly called "simulation models." Simulation models might be considered the dynamic analogue to full-cost studies. The full-cost study is a detailed investigation of resource use at a point in time. It requires examining the flow of inputs and outputs through the organization over one period in time. The simulation model is an attempt to generalize the relationships in the production process so that the behavior of full costs over different output levels can be expressed in algebraic terms as a set of simultaneous equations. Simulation models thus allow prediction of the effects of both changes in independent variables and changes in underlying relationships which are obscured in the more general single equation models:

> When the model is properly designed, it is possible to simulate the behavior as a real system and to estimate the effects of certain changes in parameters, operating characteristics, and independent variables on the dependent variables, (in this case costs) of the system.[72]

Clearly, simulation modeling is the most taxing form of cost analysis to initiate. However, once the model is constructed and once data needs have been identified, it may, in fact, be less costly to maintain than sporadic full-cost studies which are not a normal part of the duties of an institution's analytical staff.

Like full-cost studies, simulation models can vary in complexity. The separate equations used to describe various aspects of the production

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[72] Firmin, et. al. [108], p. 99.

process may, in fact, be very simple.[73] Simulation models may be constructed for all or parts of the university system.[74] A total systems model would have to be every bit as detailed as a full-cost study. Furthermore, it would require data from full-cost studies at several points in time in order to estimate the required relationships.[75]

Conclusion

The foregoing sections have outlined conceptually the elements of total social cost and have discussed in more detailed fashion the elements of institutional cost. A summary of the various means of analyzing and presenting cost information has also been presented. As one author has put it:

> It is easy to see why, because of the many choices available to cost analysts at different stages of the analysis, that each procedure tends eventually to become unique and has proven difficult to transplant from one state to another.[76]

Another conclusion is suggested by the cost studies in ther previous section. Cost studies can vary a great deal in complexity and computational manageability,

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[73]The WICHE *Resource Requirements Production Model (RRPM)*, for example, uses a relatively simple cost allocation procedure which ignores reflexivity in program relationships. Also, equations which could be subject to simultaneous equations bias were all estimated on the bias of ordinary least squares regression-techniques. See Weathersby [326], pp. 13-8. This model has been criticized for omitting activities not related to direct instruction. See Alden [5], p. 13.

[74]For a very good taxonomy of systems models in higher education see Weathersby and Weinstein [328].

[75]A number of systems analysis studies in higher education have been undertaken. The following list is representative, if not complete; consequently, such studies should be considered in the light of benefits expected from their use: Abt [1]; Abt [2]; Abt [3]; Anthony [13]; Bruno [52]; Cope [80]; Firmin, et. al. [108]; Judy [169]; Judy and Levine [170]; Kenney and Sheehan [176]; Koenig and Kenney [184]; Koenig, Kenney, and Zemach [185]; Rowe, Wagner, and Weathersby [253]; Systems Research Group [285]; and Zemach [349].

[76]Cavanaugh [66], p. 9.

and consequently in costliness.[77] In undertaking cost studies, therefore, the costliness of the study itself should be compared with expected benefits. It may well be that many of the more common uses to which cost studies are put in higher education would not justify the greatest expense for analysis.

An additional point which bears re-emphasis at the conclusion of this chapter is that there may, in fact, be a significant difference between marginal costs at different output levels. If this is the case, as has been indicated above, average costs at a single point in time are not satisfactory predictors of marginal costs in succeeding periods. This suggests that reliance on simple aggregate budgeting formulas based on historical unit costs may lead to misallocations. Consequently, there is certainly some value in attempts to determine on the basis of historical data what production relationships are and how they behave over different output ranges in order to determine marginal costs.

It must be emphasized, however, that such models are estimation techniques used as a substitute for costly and unwieldly direct computations. Consequently, there is a trade-off between the generality or simplicity of the model and the degree of fine tuning which can be expected from its results.[78] According to Firmin, _et_. _al_., this is the chief reason for continued reliance on average cost information where marginal cost information would be more desirable:

> When university accounting systems are relatively naive, administrators find it easier to generate some sort of historical cost schedules and to predict future costs and responses to change by using the same

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[77] A recent study by Peat, Marwick, Mitchell, and Company [237], has indicated that universities must incur substantial costs just to determine what the weights should be for allocating indirect costs to organized research. In one school, simply determining the direct costs of buildings and maintenance took four employees five months of full-time effort. (p. 4)

[78] See Miller [203], pp. 105-7. Miller states: "In some cases the objections to this added work outweigh the possible advantages."

> procedures normally employed in budget formulation than by attempting to build a mathematical model of cost behavior.[79]

Finally, while a given model can be used to derive estimates of marginal costs, it must be remembered that parameters of the model itself can be estimated only from historical cost patterns and subjective judgment. Inaccuracies in historical data--to the extent that they are systematic and not just random--as well as existing inefficiencies in the production process will be embodied in the parameter estimates. Therefore, the determination of historical total costs and/or average costs of the various outputs of higher education at separate points in time, together with scrutiny of the production process for inefficiencies, remain important exercises.

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[79] Firmin, et. al. [108], p. 4. Apparently the experience at Princeton has been similar. Princeton, at one point in the 1960s, rejected marginal costing not because it is wrong or inappropriate, but because it is difficult to do. See Bowen [38], p. 56:

> The University has flatly rejected the so-called "incremental" approach, primarily because of the impossibility of determining the incremental costs of any particular project or group of projects.

Appendix 3-A

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Appendix 3-B

DIRECT COST STUDIES

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CHAPTER 4

MEASUREMENT OF DIRECT COSTS

Introduction

The first problem to be faced in any cost allocation exercise is the measurement of direct costs of activities. Even a fundamental understanding of the relationships between activities at an institution of higher education will not be sufficient for accurate cost allocation if the cost of activities cannot be measured. In order to compare the effectiveness of resource use in higher education with that in other sectors of the economy, it is important to measure all costs required for the production of higher education outputs. Capital, as well as labor, costs must be taken into account.

This chapter deals specifically with three special problems which arise in the context of direct cost measurement. In the first section the definition of activities within organizational units at the basic stage of the production process--academic departments--is discussed. The second section addresses the problem of measuring academic labor costs. The third section takes up the problem of determining current opportunity costs of capital at institutions of higher education. The ideal measure of opportunity costs is discussed on a conceptual level first and then currently available alternatives for approximating current capital costs are discussed.

Departmental Activities

If every organizational unit within the institution of higher education produced a single type of output which was distributed solely to clients of the institution, and if resources employed by each organizational unit were separate and distinct from those employed by other units, direct cost measurement and cost allocation would be simple. A glance at budget accounts for each unit would indicate the total cost of producing each of the different outputs. Unfortunately for the cost analyst, the real world is not so conveniently arranged. This is particularly true of academic departments. Within these organizational units there are numerous activities, each of which may result in one or more distinct outputs. Furthermore, academic manpower is typically involved in most or all of the activities. For these reasons the measurement of direct costs of organizational units at the final stage of the production process presents what is perhaps the most difficult set of problems in any cost study for institutions of higher education.

Actually, it is incorrect to conceive of an academic department as a single stage in the production process. The existence of multiple activities resulting in multiple outputs, each of which may be used in other departmental activities, as well as being distributed to clients, means that academic departments are in fact production processes involving a number of stages. Consequently, "direct cost studies" of academic activities require not simply a measurement of resource use in activities, but an investigation of interrelationships between activities in order to allocate activity costs to final outputs.

Clearly, activity definition (which might be viewed as describing the actual production process), is a prerequisite for cost allocation. It was indicated in Chapter 2 that activity definitions coincide primarily, but not exclusively, with the outputs of activities because there may be several outputs.[1] However, this problem does not necessarily make cost allocation impossible. Cost allocation in the presence of joint products is difficult because output measures and their values are not always available, not because activities themselves cannot be defined precisely in terms of single output. Therefore, activities cannot and need not be defined exclusively in terms of a single output.

Emphasis on Faculty Activities

Without exception, cost studies in higher education which involve the allocation of costs to final outputs, whether from and instructional or

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[1]See Chapter 2, third section, pp. 56-72.

research point of view, have based their allocations on an analysis of faculty activities. In fact, typical allocations of departmental and general overhead cost pools are made by prorating these costs to the faculty activity classifications on the basis of faculty salary dollars assigned to those classifications by some means or other. For this reason the literature on faculty activity analysis should be useful as a starting point for classifying activities within academic departments.

There are many good examples of faculty activity reports available in instructional cost studies. All of them identify similar activities, but they differ in the manner in which they organize activity classifications. The WICHE Program Classification Structure as it presently stands breaks instruction down into the following four categories: (1) general academic instruction; (2) occupational and vocational instruction; (3) special session instruction; and (4) extension instruction.[2] Within these four subprograms, activities which support the instructional process--such as teaching, supervision, course preparation, and so on--are organized by academic discipline and by course level.

The *Illinois Cost Study Manual*, on the other hand, divides instruction into two general categories: (1) direct instruction, which includes all classroom contact with students, whether regular or special session, or extension for credit; and (2) indirect instruction, which includes all activities which support classroom contact, such as teaching, supervision, preparation and procurement of materials, paper grading, and so on.[3]

A third approach is taken in the "Survey of Faculty Effort and Output" of the University of California.[4] In this study a distinction was maintained between regularly scheduled courses and supervision of student independent studies. However, under the category of "regularly scheduled courses," a breakdown similar to that used in the *Illinois Cost Study Manual* was made. This category was seen as consisting of two activities: (1) actual

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[2]See Gulko [126].

[3]Duxbury [97].

[4]University of California [316]. This document is described in University of California [315].

course contact (including contact during the scheduled class hours and lectures, labs, sections, field trips, concerts, dramatic productions, etc., and also contacts with enrolled students outside class meetings, such as in office hours and other informal meetings); and (2) course preparation.

There are other variations in the classification of instructional activities, but the three examples above illustrate that classifications tend to differ more in the manner in which they organize a given set of detailed activity classifications, than in the set of activities itself. A review of the research and public service aspects of academic departments, as described in much of the recent literature on cost analysis, reveals that this is true of virtually all activities commonly considered part of academic departments.

Basic Departmental Activities

It appears that activities carried on at the departmental level can be grouped under four general headings: Instruction, Research, Public Service, and Support. In order to compile a composite of activities in academic departments, ten studies have been selected which, taken together, contain definitions of all activities commonly included under these headings. The selection of studies is in some sense arbitrary since each one chosen is representative of several studies reviewed. However, all activities included in any faculty activity survey and all specific variations in the manner of organizing activities are represented by these studies. A list of these studies is given in Appendix 4-A, and a broader list of relevant materials is included in Appendix 4-B.

The composite of faculty activity classifications organizes activities in six categories:: Instruction; Instructional Services; Departmental Research; Organized, Sponsored or Contract Research; Public Service; and Departmental Administration.

Instruction. This activity has been broken down in many ways. The main dichotomy for exposition here is between graduate and undergraduate. Another distinction is often made between direct instruction and indirect instruction. Direct instruction pertains to the actual in-class contact, while indirect instruction relates to the activities involved in preparing for classes. Under direct instruction classes may, of course, be differentiated by discipline and by regular or summer session, and by type. Types include lecture, seminar/discussion, lab, independent study, thesis supervision, and direction. Under indirect instruction activities are included lesson preparation, procurement and preparation of class and lab apparatus and supplies, out-of-class student consultation, evaluation of student work and grading, thesis examination, reading and evaluation of drafts, and examination of students.

Instructional Services. This group of activities is similar to the category of indirect instruction mentioned above. While instructional services are class- or course-related, they are not assignable to any specific class. This group contains such activities as academic committees for curricular review, committees for qualifying examinations, academic counseling, operation and maintenance of departmental libraries, operation of visiting lecturer and workshop programs, and conferences.

Departmental Research. This group of activities has been variously called "non-separately budgeted research," "non-sponsored research," and "personal or faculty research." It was defined in the *California and Western Conference Cost and Statistical Study* as "intensive study for the purpose of expanding the body of knowledge of the subjects studied."[5] Basically, there appear to be three different types of activity which can be called departmental research. First, maintenance of professional status, which includes journal reading and assimilation of new knowledge, as well as participation in seminars, workshops and conferences; second, departmentally assigned projects such as internal studies; and third, personally originated or individually motivated research which falls within a faculty member's normal academic duties and for which he receives his normal academic salary.

Organized, Sponsored or Contract Research. There appear to be three important characteristics by which research other than departmental research is distinguished. First, whether the research is conducted as a part of an on-going project or capability such as a particular institute, or whether it is a separately contracted grant or contract project is usually specified. Second, the source of funds may be either state and local, federal

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[5]University of California [314]. p. 33.

agency, private foundation, or private industrial funds. Thirdly, the type of personnel engaged in the project is important. Personnel may be entirely non-academic, or may involve both salaried student help and regular academic faculty.

Public Service. This particular category of academic activity is perhaps the least consistently defined in the literature. Generally, however, it is considered to included non-credit instruction and activities which result in service to the community other than those which produce such results as by-products of regular instructional or research activities. Various types of consulting for federal, state, local and private clients, whether or not there is any remuneration, are also included.

Departmental Administration. Departmental Administration provides services which support both students and faculty. Student-related administration includes departmental admissions, enrollments, recording and analysis of student progress, career counseling, and maintenance of extra-curricular activities such as student exchange programs and student conferences. Administrative activities which support faculty are academic committees for supervision of teaching, salary review, tenure, and appointment decisions.

While all studies reviewed by the authors do make a distinction between instruction and research as major categories of academic activities, it should be mentioned that the distinction is to a certain extent arbitrary because of the joint-product nature of many of the activities which fall under each major heading. It should also be emphasized that the purpose of making such distinctions is merely in order to have a classification structure in which to organize existing budgetary accounts. The separation of budgetary totals which result from organizing accounts in this fashion should not be interpreted as calculating the costs of outputs of these activities. These outputs are usually jointly produced and their costs are not easily separated. Cost allocation requires a thorough investigation of the production process in order to trace the use of intermediate and final outputs by departmental activities and clients. Nevertheless, if there is doubt about maintaining a distinction between Instruction and Research, even for the purpose of organizing budgetary accounts, the alternative exists of lumping all of these accounts together into one category, Instruction/Research. This term was given currency in the Henle Report, in order to take account of the over-lap of activities within the instructional and research categories. According to Henle:

> The special term "teaching-research" is used to designate that kind of research activity which is carried on with one or more apprentice researchers for whom this research involvement is part of the formal educational program and for whom, therefore, the principal investigator plays the role not only of "research administrator" but of preceptor as well.[6]

Use of this term does not appear to be common, however. In practice, cost studies appear to rely on a strict dichotomy between instruction and research.

Measurement of Academic Manpower Use

Once activities are defined, the problem remains to measure use of the academic labor resource in each activity. Two concepts appear to be current in faculty activity analysis studies. These are actual resource use and assigned resource use. The difference between the two concepts is exactly the same as the difference between budgeted expenditures and actual expenditures of an organizational unit. Determining which concept is appropriate from a theoretical point of view really depends on the purpose of the cost study. However, it is not possible to judge from the literature the extent to which results of actual and assigned academic manpower use studies would differ.

Since faculty assignments are a matter of record at most institutions of higher education, this method of measuring academic manpower use may in fact be the less costly of the two. However, to the extent that assignments are vague, it may not obviate the need for some study of actual manpower use.

Measurement of actual academic manpower use in activities currently relies on one of two alternatives: time and effort. The percentage of a faculty salary which is identified as the direct cost of a particular activity is determined on the basis of either the time or effort which the faculty member devotes to it.

While the time basis has been used widely in faculty activity

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[6]Henle [143], p. 69.

analysis,[7] it has been the subject of much criticism recently. The Henle Report, for example, has suggested that time is an unsatisfactory way of measuring faculty input because it ignores completely the degree of intensity which is required for different kinds of work. This report suggested a measure of effort, defined as some weighted average of time and the following two characteristics: (1) degree of engagement of capabilities; and (2) degree of intensity of application.[8] At Berkeley, it has apparently been concluded that while this criticism of the time measurement is correct, "no way has yet been found to measure the quality of the effort."[9]

The problem with the effort measure appears to be that it is very hard to quantify and must rely almost exclusively on the judgment of the faculty themselves. Time, at least, is an objective measure which is more easily substantiated than the effort measure. It would, at least, be an interesting question to ask what difference the two measures of faculty input make in the results of faculty activity analysis studies. The literature does not allow such comparisons now, however, since only one measure has ever been used in any given study.

Where actual measurement of time or effort is concerned, the procedure which is invariably used is some form of questionnaire. Questionnaires may be directed to all faculty, a sample of faculty members, or to departmental chairmen. Questionnaires vary from relatively simple one-page reporting forms, such as that developed by the Florida Cost Study Committee,[10] to a 17-page document such as that used by the University of California.[11] There appears to be an inverse relationship between the detail of reporting forms and the size of the reporting sample. This suggests that there is a trade-off between detailed information on time or effort distribution and the

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[7]See, for example, Butter [53], p. 22.

[8]Henle [143], p. 95.

[9]University of California [316], p. 5.

[10]Florida Cost Study Committee and the Office of the State Board of Control [111], p. 5.

[11]University of California [316].

percentage of coverage which can be assimilated with a reasonable amount of analytical effort.

Because the activity definitions in faculty activity studies at different institutions of higher education are not entirely compatible, it is not possible to make a thorough survey of the distribution of faculty time which has been measured at all institutions conducting faculty activity analyses. However, one survey of three large public institutions of higher education has been conducted. The results of this survey, both in terms of actual time distribution and percentages, are shown in Table 4-I on the following page.

These results indicate that at the institutions concerned, instructional activities make up the largest category of faculty manpower use with research, administration, and public service following in decreasing percentages. While this ranking appears to be the same as that reported in 1954-55 by the *California and Western Conference Cost and Statistical Study*, the overall percentages reported in that study were slightly higher for instructional activities.[12] It should be pointed out, however, that the latter study included at least four institutions with very small graduate programs, if any. Since research is typically associated with graduate faculty, this fact would tend to raise the average time devoted to instructional activities in the sample examined in that study.

Within the instructional category, itself, the main problem to be resolved is the distribution of faculty effort between graduate and undergraduate instruction. There are no widely accepted estimates in this regard. Such a division is likely to be very sensitive to:

1. The type of institution with respect to both the relevant emphasis placed upon graduate education and the type of graduate programs (e.g., whether Doctoral and Master's or Master's only);
2. Whether the educational program is basically research- or practice-oriented (e.g., Chemistry versus Social Work);
3. Within research-oriented programs the degree to which formal or contract research is emphasized (e.g., Physics versus Philosophy); and

[12] University of California [314], p. 29, Table 7.

Table 4-I

COMPARISON OF FACULTY ACTIVITY EFFORT DISTRIBUTIONS *

Institution	Faculty Activity ** Instruction	Scholarly	Public Service	Administration	Other	Total
A	34.7 (59.7%)	13.9 (24.0%)	1.2 (2.0%)	5.6 (9.6%)	2.7 (4.7%)	58.1 (100.0%)
B	31.3 (51.8%)	18.4 (30.5%)	1.0 (1.6%)	6.2 (10.3%)	3.5 (5.8%)	60.4 (100.0%)
C	32.3 (55.6%)	11.4 (19.6%)	3.2 (5.5%)	8.9 (15.4%)	2.3 (3.9%)	58.1 (100.0%)

**In the rows for each institution, the top figure is the average hours per week and the lower figure in parentheses is the percentage of hours per week.

*Thompson [293]. This information was provided on a basis which guarantees anonymity of institutions.

4. The perceived quality of the graduate program itself.

A thorough analysis of the relationship of such factors to faculty activity was not found in the search of the literature. In the *California and Western Conference Cost and Statistical Study* estimates of the percentage of instructional effort devoted to graduate instruction ranged all the way from 1 to 32 per cent.[13] More recent estimates suggest that the percentage of effort devoted to graduate instruction and major research-oriented graduate programs including both Doctoral and Master's level instruction generally lies between 25 and 40 per cent, again, however, being sensitive to the factors discussed above.[14]

It is safe to say that there is general agreement in the literature that one of the most crucial factors in any cost analysis is the division of faculty effort. At this point, however, there has not been enough consistent analysis to allow conclusive statements to be derived from comparisons across institutions or disciplines.

Measurement of Capital Costs

All activities at an institution of higher education are direct users of "capital." The services provided by land, plant and equipment during any time period are resource inputs into activities of the institution in the very same sense as faculty and non-academic staff "labor" services. In any study of total social costs, or of total institutional costs of higher education output, the costs of capital services should be included.

Measurement of capital use in institutions of higher education is a fairly well-developed field of cost analysis. A number of space use and space allocation manuals have been written. Basically, space studies rely on a measure such as square footage or cubic footage of actual space used, together with a prorated portion of common spaces such as hallways, stairways, ans so on, to allocate capital costs. Appendix 4-C at the end of

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[13] University of California [314], p. 28.

[14] These estimates were provided on a basis which guarantees the anonymity of the institutions involved.

this chapter is a list of sources relevant for space allocation and measurement of capital use.

Special problems arise in measuring the costs of capital services because of the multi-period character of the factors which yield these services. A physical asset yields a stream of services for more than one accounting period while the services of other inputs, for example, faculty and staff, are accounted for explicitly in a given time period by wages and salaries. There is no comparable flow of funds reflecting current value of services provided by physical assets. The intent here is to provide a meaningful conceptual framework for determining the costs of capital, and to suggest alternative means for estimating these costs.

The Opportunity Costs of Capital

With respect to the land, plant, and equipment currently owned by institutions of higher education, the opportunity cost could be defined as the current resale value of these assets, net of all marketing and transfer costs. It is important to point out that the opportunity cost of any resource which yields benefits for more than one accounting period is not simply the opportunity cost of current services. The opportunity cost of an asset, and consequently its market value, is equivalent to the discounted sum of the opportunity costs of its services in each period of its life. This value may include social (i.e., tax) as well as private value foregone.

"Discounting" of benefits which accrue in future periods simply means the correction of their value to reflect time costs, in other words, the costs of having to wait to enjoy them[15] An important feature of discounting is that it reduces the size of benefits which accrue in remote periods to practically insignificant amounts. For this reason, even non-depreciable assets, such as some types of land, have a finite price. For example, the present value of $100 which will accrue in twenty years is about $18.50, using a 7 per cent discount rate. The present value of $100 paid at the end of fifty years is roughly $1.50. In other words, discounting the value of a benefit expected at the end of fifty years can eliminate nearly 99 per cent of it. Thus, while the opportunity cost or market

[15] H.E.W. [308], p. 18.

value of any physical asset consists of the sum of opportunity costs of its services in each period of its remaining useful life, time costs are netted out of the value of services accruing in future periods.

Under competitive market conditions, interest foregone on the net resale value of an asset will be equivalent to the rental value of the asset. If the asset depreciates in value over the time period in which it is held, either through use or through general economic conditions, this change in resale value, which is a measure of capital consumption, is also included.[16] This point might be illustrated with reference to a simple example: Suppose an automobile is purchased at the beginning of one time period for $3,000 and is used for one year. The cost of using the automobile consists of the interest foregone on the $3,000 for one year plus the change in value of the car over the period. Suppose the funds committed to purchase of the car originally could have earned endowment income at the rate of 7 per cent a year; also suppose that the car is sold for $1,500 at the end of the year; then the total cost of using the car for one year has been the interest foregone on the original book value, or $271, plus the drop in value over the period, or $1,500 which yields a total cost of $1,771. Thus, interest on net resale value must be combined with whatever depreciation occurs while the asset is used.

Before discussing techniques currently used in estimating capital costs it is important to distinguish depreciation of asset value in the economic sense described above from depreciation in the accounting sense. In the accounting sense of the term, depreciation is an assigned reduction in the book value of an asset, according to more or less arbitrary rules for distributing the acquisition cost of the asset over several time periods. The accounting concept is one of extreme importance when an institution is subject to the corporate income tax. However, for purposes of estimating the true costs of activities in institutions of higher education, it is much less appropriate.[17]

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[16] O'Neill [230], p. III-21. See also Bolton [36], p. 25.

[17] This fact has been pointed out by the American Council on Education in its recommendation against the use of such accounting concepts of depreciation in A.C.E. [8], pp. 285-9.

In the economic sense, depreciation in asset value has a much different meaning. From the moment as asset is created, two separate forces act to "consume it" or use up its value in each period. In the first place, actual use of an asset wears it out in a physical sense. In the second place, improvements in technology or changes in the nature of needs which the asset was designed to serve make it obsolete. Since physical deterioration through use or through the aging effects of natural forces may be relatively easy to anticipate, this is probably taken into account in the original book value of the asset. If this were the only force acting to consume capital, then a simple prorating formula might not diverge that much from a measurement of actual cost. However, obsolescence is much more difficult to predict and is probably less often reflected in book value. Future benefits are subject to risk and uncertainty. It is, therefore, likely that the original price of an asset will not fully anticipate the stream of benefits which will actually result.

While the connotation of the term "obsolescence" is negative, implying an unfavorable change in demand, demand conditions can change in the opposite direction as well. In the latter case, the value of the asset may actually increase over time. It does not seem unlikely, for example, that the value of land occupied by many older institutions of higher education was not fully anticipated by its donors. Furthermore, since many of the buildings in institutions of higher education become invested over the years with the role of perpetuating architectural or cultural traditions, the possibility also exists that such assets actually increase in value over time.

In other words, quite apart from the actual physical use of assets, general economic conditions also act to change asset value over time. As a result, accounting techniques which amortize the book value of the asset over a fixed life span may result in inaccurate measures of depreciation in the economic sense. The appropriateness of the opportunity cost concept is that it recognizes the effects of all real forces operating in society upon the value of capital stocks and therefore the period-by-period cost of capital services.

The Estimation of Capital Costs

The rental value or interest on net resale value plus value consumed represent the ideal measure of the opportunity cost of an asset. However, for a number of reasons, neither of these measurements is very often available. In the first place, current net resale value of an asset is a hypothetical number as long as the asset is being used. For some types of equipment it is possible that resale value after known periods of use can be estimated from transactions in the private sector. However, the kinds of land and buildings, their locational distribution, heating, ventilation, and other utilities typically found on campuses may not have counterparts in the private sector of the economy. In the second place, these facilities are probably a very small part of the total.[18] Furthermore, it is not customary in university accounting to provide formally for the costs of land.[19]

In the absence of readily available information on actual capital or land costs, such as would be available if institutions of higher education typically rented equipment, buildings, space or land, the central problem is to derive reasonable estimates for the costs of current capital services. A number of procedures are currently in use.

The Historical Costs Approach. The most commonly used procedure might be termed the "sum of historical costs" approach. Buildings are assumed to have a life of 50 years and are depreciated in a straight line over this period. Thus, the cost of current capital services is assumed to be 2 per cent of the acquisition cost of the asset. Equipment is depreciated over fifteen years, thus making the cost of the asset in any period 6-2/3 per cent of the original purchase value.

Clearly, this approach is appropriate only for purposes of investigating institutionally borne costs of capital, since it does not include interest on the value of the asset. For this purpose, however, the computational manageability of the technique makes it attractive.

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18 O'Neill [230], p. III-13.

19 H.E.W. [308], p. 114. See also Knott [183], Introduction.

The historical costs approach does involve problems, however. The first problem is that using the original dollar cost figures does not correct for inflation. This may result in an understatement of costs in terms of current dollars. For this reason it should be considered a means of obtaining lower-bound estimates of current institutionally-borne costs of capital. A second problem referred to already is that the depreciation concept may not measure actual use costs.

Since most instructional cost studies done in institutions of higher education have been concerned exclusively with operating costs and since social rate of return studies would require total social costs and therefore include interest, in addition to principal or book value, the historical cost approach has not been used in either type of study. It is, however, a required aspect of accounting on federal grant and contract awards, and is therefore information which is currently available at institutions of higher education which deal with the federal government. Furthermore, O'Neill has pointed out that historical cost studies do provide a means of identifying investment flows at the time they were made, since the difference in the stock at original cost between two years roughly represents the amount of gross capital expenditures during the year.[20]

<u>The Debt Service Approach</u>. The historical costs approach may be inaccurate for a number of reasons; however, even if it did yield an accurate measure of capital consumption in any period it would not represent the social or opportunity cost of services provided by the asset. The debt service approach is one which amortizes both principal and interest of the original debt value over the predicted useful life of the asset. Suppose for a moment that debt servicing of an asset purchased by an institution of higher education was done in the following manner. In each period a simple pro-rated portion of the principal is repaid, plus interest on the remaining balance. In other words, the only difference between the debt service approach and the historical cost approach would be the addition of interest on the remaining undepreciated value of the asset. If the straight line depreciation were an accurate measure of capital consumption in each period and if expectations concerning market conditions have been fairly accurate,

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[20] O'Neill [230], p. III-21.

this approach may yield period-by-period charges which come close to taking account of current opportunity costs of capital services.

Under such a debt service scheme, the total charge for each period would decline over time. Early period payments would consist of a large interest component while later period payments would be almost all principal. By convention, however, actual debt service charges are typically held constant over time in order to avoid uneven demands on sources of revenue. In other words, early period payments are composed of a relatively larger interest component and a relatively smaller principal component. For example, with a 30-year loan at 7-1/2 per cent annual interest rate, the payment is 99.1 per cent interest in the first year, over 98 per cent in the second year, and so on, being over 90 per cent for the first ten years. It is likely that this type of repayment schedule understates current costs of capital services in early periods and overstates them in later periods, if capital consumption, i.e., economic depreciation, operates in a more or less linear fashion over time. If it occurs in a decelerating fashion over time, as is sometimes assumed, then the debt service approach gives an even greater understatement of current capital service costs in the early periods and a greater overstatement in later periods.

Debt financing of capital construction in institutions of higher education is not common. For both public and private institutions, capital financing is typically made on the basis of grants. In such cases the opportunity costs of the funds committed are borne by the donors of the funds themselves, and the historical costs approach gives an accurate measure of costs borne by the institution. Nevertheless, as long as the asset has a resale value, the decision to hold the asset for further use foregoes potential interest. In this sense the full social cost of the asset is relevant for institutional decision-making.

The debt service approach, since it amortizes both the principal and interest of the original debt value of some predicted useful life of the asset, is a means of estimating the full opportunity cost of current capital services. A variation of this approach is suggested in a description of a cost model developed by the University of Kentucky.[21]

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[21]University of Kentucky [317].

Another variation of the debt service approach has been used by Stager, who imputes a 5 per cent interest rate to the original book value of assets in order to arrive at a synthetic measure of debt servicing.[22]

The Equivalent Rental Rate Approach. The opportunity cost concept recognizes the effects of all real forces operating in society upon the value of capital stocks and therefore the period-by-period cost of capital services. The debt service approach estimates current opportunity cost of capital services by using a combination of interest and principal, in other words, the debt service approach relies on the acquisition cost of the asset. For a number of reasons mentioned earlier, acquisition cost or the original price of the asset may not fully anticipate economic changes which take place later on in the life of the asset. The current rental rate on facilities which are leased will always take these changes into account. Since leasing is not common at institutions of higher education, actual rental rates are not often available.

The equivalent rental rate approach involves the closest of all measures to actual current opportunity cost without being the real thing. Plant and equipment of equivalent types in surrounding localities which are leased are investigated to determine the effective rental rate per square foot. This rate is then applied to the plant and equipment owned by the university. A variation of this procedure has been suggested by Hirschl,[23] and an effective rental rate is used in most rate of return studies.[24]

As in all such cost analysis studies, the costs of gathering information have to be weighed against the value of accurate cost estimates. Depending on the intended use of cost information, it is entirely possible that "true" capital cost information may be more expensive to collect than it is worth. Furthermore, the kinds of facilities typically found on campuses may not have counterparts in the private sector of the economy, which makes determining rental information complicated and expensive. At

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[22] Stager [276], p. 3.

[23] Hirschl [151].

[24] Butter [53].

the same time, the benefits from such information may be limited.

Because of the limited number of studies which have included capital costs, it is not possible to characterize the range of percentages which capital costs occupy in total degree costs. Irene Butter has estimated that that between 5.3 and 14.9 per cent of degree costs are capital costs.[25] Much higher percentages have been found elsewhere.[26] If the percentage of capital cost makes up only on the order of magnitude of 8 per cent of the total estimated instructional cost, then accuracy in measuring capital costs may not be very important. Even if precise estimates resulted in as much as doubling capital costs, as a percentage of the total, the final effect upon total cost estimates would be an increase only in the neighborhood of 5 per cent. Clearly, in such a case the final results are not very sensitive to the manner in which capital costs are measured. Consequently, extensive efforts to measure capital costs might not be justified in cases where they do not represent a major portion of total costs.

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[25] Butter [53], p. 32.

[26] Dodge and Stager [93], p. 30.

Appendix 4-A

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Appendix 4-B

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CHAPTER 5

PROCEDURES FOR INDIRECT COST ALLOCATION

Introduction

As noted earlier, the problem of determining the costs, including "indirect" costs, of final outputs is not a problem unique to institutions of higher education. However, because institutions of higher education operate basically in a non-market environment in which the values for outputs are not automatically determined, the problem of cost determination and cost allocation is much more difficult to solve. Nevertheless, cost studies in higher education have been undertaken throughout most of the 20th Century. For the most part, these studies have focused upon average costs, attempting to determine suitable education and research output proxy measures and to determine the share of total costs which can be attributed to their production.

Costing for this purpose involves both a detailed accounting of the direct costs associated with an activity and allocation of so-called indirect costs, which really amount to the direct costs of activities which are one or more steps removed from the primary output-producing activities. It is generally acknowledged that the largest component of direct costs lies in the area of academic personnel costs. The problem of determining direct costs is thus basically one of determining what is the relationship between various faculty activities and the various dimensions of education, research, and public service outputs. As indicated previously, estimation in this area has relied traditionally upon faculty activity or assignment analysis.

The determination and allocation of indirect costs, however, also may bear heavily upon central policy issues such as setting tuitions, subsidizing research, assessing the returns to past graduate and undergraduate educational investments, and, at least in the long-run context, allocating future resources. This chapter is addressed to the problem of indirect cost allocation.

Historically, three general procedures have been used to determine full costs of higher education. For the most part they have been used to allocate overhead expenses to some proxy measure for instructional outputs, although the procedures are applicable to the organized research and public service aspects of the institution of higher education as well.

The procedures commonly used vary in computational difficulty and the important feature in this regard is the way in which the degree of computational simplicity relates directly to what assumptions are made, implicitly or otherwise, concerning the nature of relationships among the activities within an institution of higher education. The purpose of this chapter is to present a consistent framework within which the commonly-used allocation procedures may be examined and compared. The vehicle for the framework is the Leontief Input/Output Table.[1] The value of this tool is that it indicates the crucial manner in which allocating indirect costs depends on the interrelationships among activities within an institution of higher education, and demonstrates how an allocation procedure which misrepresents the true relationships within the institution may result in biased cost figures.

The chapter is organized in the following manner: First, all activities of an institution of higher education are conceptually classified and included in one of seven "programs" as defined by the WICHE Program Classification Structure.[2] Next, the input/output format is used to show how program relationships might be pictured. Third, the program relationships implicit in commonly-used indirect cost allocation procedures are discussed. Finally, in Appendix 5-A, a general solution is presented which, unlike presently used procedures, places no arbitrary restrictions on program relationships. In the text of the chapter the discussion is as non-mathematical as possible. The mathematical relationships underlying the discussion are presented in Appendix 5-A.

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[1]This is discussed at some length in Dorfman [95]; and in Lancaster [188].

[2]Gulko [126].

Methodologies of Indirect Cost Allocation

Classification of Activities in an Institution of Higher Education

Some aggregation of activities is a prerequisite for a meaningful discussion of the relationship between inputs and outputs of institutions of higher education. However, at present, activity definitions and classifications are rarely identical across institutions. In order to have a basis for discussion and comparison, we have found it necessary to adopt a classification system which has at least a tentative acceptance on a national level. The WICHE Program Classification Structure comes closest to satisfying this need. At the time of this writing the latest available version of the WICHE report is that of March, 1971.[3] The organization of the Program Classification Structure as presented there is diagrammed on the following page in Figure 5-1.

It will be seen that the WICHE Program Classification Structure groups activities of an institution of higher education into seven major categories. The purpose of grouping activities in this way is in essence to focus the attention of funders, clients and administrators on the results or outputs of all activities. It must be made clear, however, especially with respect to "primary" programs, that the program itself is only an aggregation of activities which are more or less homogeneous in primary intent, and which may have other outputs or by-products which differ from those specified as primary intent. Program definitions, in other words, encompass primarily <u>but not exclusively</u>, the outputs of the activities included therein. The problem arises because there are many "joint activities" which produce more than one output and the production processes are not easily separated.

Program classification in the presence of joint production is doomed to be an imperfect enterprise. However, regardless of how a program is defined, if inputs associated with it can be measured, its outputs measured and valued, and users of the outputs identified, meaningful cost allocation can still be achieved. Program definition is, then, meant to be a helpful

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[3] Gulko [126].

Figure 5-1

ORGANIZATION OF THE WICHE PROGRAM CLASSIFICATION STRUCTURE

CAMPUS

PRIMARY PROGRAMS

SUPPORT PROGRAMS

.0 INSTRUCTION	2.0 ORGANIZED RESEARCH	3.0 PUBLIC SERVICE	4.0 ACADEMIC SUPPORT	5.0 STUDENT SERVICE	6.0 INSTITUTIONAL SUPPORT	7.0 INDEPENDENT OPERATIONS
.1 General Academic	2.1 Institutes & Research Centers	3.1 Continuing Education	4.1 Libraries	5.1 Social & Cultural Development	6.1 Executive Management	7.1 Institutional Operations
.2 Occupational & Vocational	2.2 Individual or Project Research	3.2 Community Service	4.2 Museums & Galleries	5.2 Supplementary Educational Service	6.2 Fiscal Operations	7.2 Outside Agencies
.3 Special Session Instruction			4.3 Audio/ Visual Services	5.3 Counseling & Career Guidance	6.3 General Administrative Services	
.4 Extension Instruction (for credit)			4.4 Computing Support	5.4 Financial Aid	6.4 Logistical Services	
			4.5 Ancillary Support	5.5 Student Support	6.5 Physical Plant Operations	
			4.6 Academic Adminis-tration		6.6 Faculty & Staff Services	
			4.7 Course and Curriculum Development		6.7 Community Relations	

ource: Gulko, Warren W., "Program Classification Structure." Preliminary Edition for Review. Boulder, Colorado: Western Interstate Commission for Higher Education, June 1970, as revised March 1971. (Unpublished)

A later version of this structure is found in Minter, John W., "Faculty & Staff Assignment Classification Manual: Preliminary Edition," Technical Report No. 18. Boulder Colorado: The National Center for Higher Education Management Systems at the Western Interstate Commission for Higher Education, June 1971. (Unpublished) step in sorting out fairly homogeneous activities, but precision is not a necessary condition for cost allocation.

The importance of this point cannot be overstressed. In practical terms it means that the existence of more than one product which comes out of any activity does not automatically make cost allocation impossible. Difficulties in determining costs of some outputs may arise but the reason will be that we cannot arrive at output measures or determine values for the various outputs, not that programs are not defined exclusively in terms of a single output.

The WICHE Program Classification Structure is useful because it is a well-organized and relatively complete description of activities at an institution of higher education. Insofar as possible, we have attempted, for discussion purposes, to translate the cost studies reviewed into this classification scheme. Such a translation is bound to be imprecise, and as a result reference to specific program interrelationships as they appear in any particular cost study should be interpreted broadly. On the other hand, the discussion of the principles underlying cost allocation methodologies is not affected by minor discrepancies.

The General Framework--Program Relationships

The objective in this section is to develop a framework within which program relationships can be discussed and compared. The question of how actually to attach measures to these relationships is postponed to Chapter 6. Since we are concerned only with the question of whether a relationship between any two programs exists at all, a simple two-dimensional matrix is used for purposes of exposition. Using six of the seven WICHE program definitions,[4] and listing these down the side and across the top of a six-by-six square matrix, we can summarize in the most general way possible all of the relationships between programs in an institution of higher education. Such a matrix is shown in Figure 5-2 on the following page. The rows are meant to represent the programs in the "production" sense and the columns to represent the programs which use or "consume" the output produced

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[4]"Independent Operations," as a category which contains mostly activities unrelated to the primary missions of the institution, is eliminated.

Figure 5-2

PROGRAM RELATIONSHIP MATRIX

PROGRAM OUTPUTS
DISTRIBUTION BY USER PROGRAM

PRODUCING PROGRAMS	1. Instruction	2. Organized Research	3. Public Service	4. Academic Support	5. Student Service	6. Institutional Support	Use By Clients of the Institution of Higher Education
1. Instruction							
2. Organized Research							
3. Public Service							
4. Academic Support							
5. Student Service							
6. Institutional Support							
Direct Program Costs	$	$	$	$	$	$	

by each program. We include an extra column to show final program outputs, i.e., those used by the "clients" of the institution, students, and/or society at large. The fact that one program contributes part of its output to another or to outside clients can be represented by placing a check in the box formed by the intersection of the row corresponding to the "producer" program and the column corresponding to the "consumer" program.

For the sake of discussion this matrix shall be called the Program Relationship (PR) Matrix. The PR Matrix is a useful tool for two reasons:

1. It provides at a glance a comprehensive picture of the way in which programs (or activities) of an institution of higher education are related.
2. It allows discussion, independent of the problems of measurement, of how costs of Support programs might be allocated to Primary programs. In fact, it will be shown later that the cost allocation procedure which is appropriate for an institution of higher education depends precisely on the form which the PR Matrix takes.

The exposition here is deliberately simplified. Programs have been left at a high level of aggregation and all questions of measurement or evaluation have been put aside so that the immediate link between program relationships and cost allocation procedures can be made clear. Inevitably at this level of aggregation and simplification, certain specific relationships may seem somewhat unrealistic or arbitrary, and the reader is urged not to be overly literal in his interpretation of the specific program relationships used as examples.

The important thing to be gained from the discussion is the way in which cost allocation procedures depend on program relationships. The following example may serve to illustrate this: Suppose an analyst has been asked to develop a cost allocation procedure appropriate for his institution of higher education. Assume he draws a chart corresponding to the PR Matrix mentioned above and proceeds by means of questionnaires, consultations with knowledgeable associates, and his own judgment, to describe the program relationships which exist at his institution.

The analyst's research may yield the following results (unique as they may appear to be): He finds that all of the activities of Program 6, Institutional Support, contribute to Programs 1, 2, 4, and 5, Instruction, Research, Academic Support, and Student Services. The analyst denotes this by placing a b_{ij} in the boxes formed by the intersection of columns two, four and five with row six; each b_{ij} represents the proportion of the i'th program's service output consumed or used by Program j. Suppose Program 5, Student Services, is found to contribute only to Program 1, Instruction, requiring a b_{51} in the box formed by the intersection of row five and column one. The activities in Program 4, Academic Support, are found to contribute to Programs 1, 2, and 3, Instruction, Organized Research, and Public Service, calling for b_{ij}'s in the first three boxes of row four. Finally the primary programs 1 through 3 are found to contribute all of their outputs to clients of the institution as shown by the x's in the first three boxes of the last column.

When finally completed, then, the PR Matrix presents a concise picture of the relationships between the various activities within an institution of higher education (see Figure 5-3 on page 159). At this point the analyst may then begin to develop an allocation procedure which is appropriate for the institution. He recommends that Program 1 be assigned the total costs of Program 5, as well as a share of the direct costs of Programs 6 and 4; and that Program 2 be assigned a share of the direct costs of Programs 4 and 6. More specifically, the procedures may be summarized in the following three expressions for total costs of the primary programs:

$$TC_1 = S_1 + (S_5 + b_{65}S_6) + b_{61}S_6 + b_{41}\ (S_4 + b_{64}S_6)$$

$$TC_2 = S_2 + b_{42}\ (S_4 + b_{64}S_6)$$

$$TC_3 = S_3 + b_{43}S_4$$

where TC_1, TC_2, and TC_3 are the total costs of the three primary programs; S_1, S_2, . . . S_6 are simply the direct costs of Programs 1, 2, . . ., 6, expressed in dollars; and b_{ij} is seen to be the proportion of Program i's cost assigned to Program j on the basis of the proportion of program output used or consumed by Program j. Of course, the unit cost study is far from completed. A fairly extensive direct cost study must still be conducted to determine what the direct costs of each of the programs are, and a way must

Figure 5-3

PROGRAM RELATIONSHIP MATRIX: ILLUSTRATIVE EXAMPLE

PROGRAM OUTPUTS
DISTRIBUTION BY USER PROGRAM

PRODUCING PROGRAMS	1. Instruction	2. Organized Research	3. Public Service	4. Academic Support	5. Student Service	6. Institutional Support	Use by Clients of the Institution of Higher Education
1. Instruction							x_1
2. Organized Research							x_2
3. Public Service							x_3
4. Academic Support	b_{41}	b_{42}	b_{43}				
5. Student Service	b_{51}						
6. Institutional Support	b_{61}	b_{62}	b_{63}	b_{64}	b_{65}		
Direct Program Costs	S_1	S_2	S_3	S_4	S_5	S_6	

be found to estimate the b_{ij}'s. However, the analyst may be confident that, at least, errors which could arise from the use of a cost allocation procedure based on incorrect program relationships will be avoided.

This over-simplified example demonstrates that the principle underlying the allocation of overhead costs is that of use. In the example it is assumed that all of the services of Program 5, Student Support, were provided to the participants in Program 1, Instruction. Therefore, all of the costs of this program, both direct and indirect, were allocated to Program 1, and so on. Conceptually, this is exactly the same principle as used in determining program direct costs, e.g., dividing faculty costs over Instruction, Research and Public Service. Direct cost accounting through faculty assignment or activity analysis is simply a measure of the departmental inputs used (or consumed) in each activity.

It is entirely consistent, then, that indirect cost accounting be based on the measurement of the use of all other intermediate outputs, manufactured internally by the support programs. The question of whether one program uses any of the outputs or services produced by another is logically prior to the question of how to measure or approximate use. It is necessary, therefore, to discuss the implied program relationships of various indirect cost allocation techniques even on this simplistic level, before dealing with the problem of actual cost measurement. The following section discusses three basic procedures which the literature shows are commonly used. In each instance the PR Matrix which is implied is presented.

Program Relationships Implicit in Commonly-Used Cost Allocation Procedures

In this section specific cost allocation procedures are shown to imply a very definite kind of PR Matrix for an institution of higher education. This exercise may be helpful for the potential user of cost allocation methodologies because in clarifying the implications which underlie different allocation procedures it provides a basis for determining conditions under which a given procedure may be appropriate.

After examining over a hundred cost studies done from the 1920s through the present, the authors feel that the indirect cost allocation procedures commonly used can be classified into three general categories according to the PR Matrix implied.

The Simplistic Procedure. The simplest of all procedures encountered in the literature really amounts to a shortcut to cost allocation. It has never been presented or proposed as a formal approach for anything other than "first cut" figures. Basically, this procedure treats an institution as consisting of several output programs, usually defined as some variation of Instruction, Sponsored or Organized Research, and Public Service. It is assumed that the only costs associated with producing the non-instruction outputs are those which can be identified as direct costs in the research and/or public service areas. Stated another way, all of the support programs of the university are seen as contributing only to the instructional or degree programs. Consequently, total costs of the Instruction program are instruction direct costs plus the sum of all support program costs. Notationally, the total costs for the three primary programs are, then:

$$TC_1 = S_1 + S_4 + S_5 + S_6$$

$$TC_2 = S_2$$

$$TC_3 = S_3$$

where S_i, as previously, refers to the direct costs of the i'th program.

In terms of the PR Matrix this procedure requires the assumptions that the intersection of rows and columns under the programs Research and Public Service contain all zeros, as do all other cells in the matrix with the exception of those in column one. This matrix is presented in Figure 5-4 on the following page. It will be noted that any interrelationships between support programs become irrelevant as far as the allocation procedures are concerned. This is because all support programs are assumed to contribute only to Program 1. This PR Matrix underlines the fact that the Simplistic Procedure really is a simple technique used in place of, rather than for, indirect cost allocation.[5]

The Direct Procedure. The technique probably most commonly relied upon for indirect cost allocation might be termed the Direct allocation

[5] An example of the application of this technique is shown in University of Nevada [318].

Figure 5-4

SIMPLISTIC PROCEDURE

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IMPLICIT FORM OF PROGRAM RELATIONSHIP MATRIX

PROGRAM OUTPUTS
DISTRIBUTION BY USER PROGRAM

PRODUCING PROGRAMS	1. Instruction	2. Organized Research	3. Public Service	4. Academic Support	5. Student Service	6. Institutional Support	Use by Clients of the Institution of Higher Education
1. Instruction							x_1
2. Organized Research							x_2
3. Public Service							x_3
4. Academic Support	$b_{41}=1$						
5. Student Service	$b_{51}=1$						
6. Institutional Support	$b_{61}=1$						
Direct Program Costs	S_1	S_2	S_3	S_4	S_5	S_6	

procedure. It is more complicated than the Simplistic Procedure because it allows for the possibility that support programs exist not only to serve instructional programs, but also to serve the other two primary output-producing programs. In particular, the Direct Procedure involves the following two assumptions:

1. Primary programs are separable and their outputs are used or consumed only by clients of the university.
2. All support program activities contribute directly and exclusively to the primary programs.

The PR Matrix implied by the Direct Procedure is shown in Figure 5-5 on page 162. The assumption that all support activities contribute directly and exclusively to the primary programs is expressed by the fact that all columns to the right of column three are left blank. Under this procedure it is possible to find the total costs of primary programs simply by adding to the direct program costs a share of the costs of each of the support programs. The "appropriate share" is conceptually dependent upon the percentage of the support program output which is consumed by the primary program in question.

An important characteristic of the Direct Procedure is the absence of any assumed relationships among support programs themselves. This allows for the allocation of costs for one support program at a time to each of the primary programs. Notationally, total costs of the primary programs can be expressed as follows:

$$TC_1 = S_1 + b_{41}S_4 + b_{51}S_5 + b_{61}S_6$$

$$TC_2 = S_2 + b_{42}S_4 + b_{52}S_5 + b_{62}S_6$$

$$TC_3 = S_3 + b_{43}S_4 + b_{53}S_5 + b_{63}S_6$$

where, once again, S_i represents the direct costs in dollars of Program i, and b_{ij} represents the proportion of Program i's output used by Program j.

While the Direct Procedure embodies more realistic assumptions concerning the nature of the "production process" and program relationships at an institution of higher education, it still has the virtue of computational simplicity. Support programs are distributed to all primary programs, but under assumptions which makes it possible to treat each support program separately without having to become involved in relationships among

Figure 5-5

DIRECT PROCEDURE

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IMPLICIT FORM OF PROGRAM RELATIONSHIP MATRIX

PROGRAM OUTPUTS
DISTRIBUTION BY USER PROGRAM

PRODUCING PROGRAMS	1. Instruction	2. Organized Research	3. Public Service	4. Academic Support	5. Student Service	6. Institutional Support	Use by Clients of the Institution of Higher Education
1. Instruction							x_1
2. Organized Research							x_2
3. Public Service							x_3
4. Academic Support	b_{41}	b_{42}	b_{43}				
5. Student Service	b_{51}	b_{52}	b_{53}				
6. Institutional Support	b_{61}	b_{62}	b_{63}				
Direct Program Costs	S_1	S_2	S_3	S_4	S_5	S_6	

support programs.[6]

The Recursive Procedure. This procedure, in comparison with the previous two, is considerably more involved computationally and requires knowledge of the manner in which the activities or outputs of support programs are related to each other, as well as to primary programs. The fact that support program interrelationships are taken into account means that the Recursive Procedure in effect involves less restrictive conceptual assumptions as to the nature of the production process within an institution of higher education than do the previous two procedures.

Basically, the Recursive scheme works as follows: All components of the support programs are classified according to the stage in the production process at which they occur, i.e., those which are assumed to provide the widest support of all activities are identified first, those which provide the next widest support, second, and so on. Next, beginning with the earliest stage, costs are allocated over all of the remaining stages, including support and primary programs, until finally only the primary programs remain. The assumptions implicit in this procedure are:

1. It is possible to identify stages in the production process, that is, activities which occur earlier or later than others, and each support component can be assigned to a single stage.
2. Support programs may contribute directly to any other program except those in the earlier stages of production.

The PR Matrix implicit in the Recursive Procedure is shown in Figure 5-6 on page 164. It will be noted that a result of the two assumptions above is the characteristic step-like appearance of the non-zero elements. It is this aspect of the Recursive Procedure which has caused it to be variously titled the "step-down" or "step-forward" indirect cost allocation technique.

Quite obviously, the indirect cost computations involved in the Recursive scheme are involved and the expressions are complicated because at each stage of allocation the total costs for support programs contain both direct and allocated costs from earlier stages. Therefore, the mathematical development of these expressions has been left for Appendix 5-A. For purposes of comparison with the previous two formulas, however, the

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[6] A good example of this basic technique is contained in Hagen [130].

Figure 5-6

RECURSIVE PROCEDURE

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IMPLICIT FORM OF PROGRAM RELATIONSHIP MATRIX

PROGRAM OUTPUTS
DISTRIBUTION BY USER PROGRAM

PRODUCING PROGRAMS	1. Instruction	2. Organized Research	3. Public Service	4. Academic Support	5. Student Service	6. Institutional Support	Use by Clients of the Institution of Higher Education
1. Instruction							x_1
2. Organized Research							x_2
3. Public Service							x_3
4. Academic Support	b_{41}	b_{42}	b_{43}				
5. Student Service	b_{51}	b_{52}	b_{53}	b_{54}			
6. Institutional Support	b_{61}	b_{62}	b_{63}	b_{64}	b_{65}		
Direct Program Costs	S_1	S_2	S_3	S_4	S_5	S_6	

following abbreviated notational formulas for the total costs of Primary programs are presented:

$$TC_1 = S_1 + b_{61}TC_6 + b_{51}TC_5 + b_{41}TC_4$$

$$TC_2 = S_2 + b_{62}TC_6 + b_{52}TC_5 + b_{42}TC_4$$

$$TC_3 = S_3 + b_{63}TC_6 + b_{53}TC_5 + b_{43}TC_4$$

where the S_i represents direct costs of the Primary programs, the TC_i represents total support program costs, including whatever other costs have been allocated of the Primary programs, and the b_{ij}'s represent the proportion of the output of Program i used or consumed by Program j.[7]

Conclusion

To review briefly, three general procedures for the allocation of indirect costs to primary programs have been discussed. Each procedure, with some variation, has been used in unit cost studies undertaken at institutions of higher education for the last several decades. A survey of many of these studies has shown that classification of the majority of cost allocation studies is possible according to this breakdown. Because such information would be useful to those with the responsibility for designing and implementing a unit cost study, an appendix of studies is provided. A selection of methodological papers and actual cost studies which propose or attempt allocation of indirect costs is listed in alphabetical order. The date of each report is given, together with some information as to which general procedure is employed (or proposed) and the "unit" to which final calculated costs of the instructional program are ultimately allocated. The list is not exhaustive but presents a representative sample (see Appendix 5-B).

At this point, some further observations are warranted concerning the nature of the allocation procedures discussed. Problems of actual measurement aside, each of the three procedures relies upon relatively straightforward computations. It should be evident, however, that computational ease rests heavily on the simplifications assumed about the nature of the production process (as represented by the PR Matrix). As a more

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[7] An example of this general technique is given by Rust in [257].

specific example, consider the Recursive technique in light of a further breakdown within programs as shown on page 152 above. Within the program, Institutional Support, the subprogram General Administrative Services (6.3), may provide various services for Physical Plant Operations (6.5). This would imply that to determine the total costs of Physical Plant Operations, some of the costs of the General Administrative Services (6.3), would have to be allocated to Physical Plant Operations (6.5). However, it is also probable that Physical Plant Operations provides services to General Administrative Services. Thus, at the same time, some costs of (6.5) should be allocated to (6.3). There is no simple way out of this dilemma. One approach is to assume that a contribution goes only one way, which gives rise to the term "Recursive."

As a digression, a similar problem results in attempting to take account of the generally agreed fact that primary program activities themselves contribute to the other primary program activities. For example, with little doubt there are research outputs (i.e., the results of various kinds of research activity) which are consumed by participants in instructional activities. Some interim research results, for example, may be used in relation to graduate or undergraduate instruction. Faculty members become better teachers as a result of work they have done on research projects and the improvement in their skills is thus a direct input into the instructional program. Similarly, certain instructional activities, such as graduate seminars, may contribute significantly to research projects. These particular problems are discussed at greater length in Chapter 7.

The point to be made here is that it is very difficult to select particular programs, whether support or primary, within an institution of higher learning, as being the producers of outputs used by other programs without at the same time being consumers themselves of some of the outputs of these same programs. This explicitly raises what may have already been an obvious point. Of the three basic procedures which have been used to allocate indirect costs at an institution of higher education, all ignore certain program interrelationships and thus some amount of validity is lost in the interest of achieving computationally manageable results. In Appendix 5-A a general procedure is developed which places virtually no restrictions on the interactions between programs in the production process.

This procedure allows all elements in the PR Matrix, including the column entitled "Final Demand" to be non-zero. In other words, all programs can provide services to each other, as well as to clients outside of the institution. This approach might be labeled the "General Solution Formula." As shown in Appendix 5-A, while it requires considerably more data and is computationally much more complicated, it is the only one which does not make restrictive assumptions about program interrelationships.

Appendix 5-A

TECHNICAL APPENDIX

Introduction

This section develops mathematically an expression which takes account of all possible program relationships. That is, no assumptions restricting the content of cells of the PR Matrix to zero are embodied in the formula. With reasonable measures for all support and primary program outputs, then, this procedure would yield the best unit cost estimates. We begin by verbally outlining the arithmetical steps used.

The unit cost of any output produced for university clients may be expressed as some weighted aggregation of the direct costs of each program. The method presented here relies heavily on the theory of input/output models developed several years ago by economist Wassily Leontieff at Harvard.[8] It should be pointed out that this formula also allows the user to take explicit account of any program which produces output for final demand, not just those designated as "primary" programs in the WICHE Program Classification Structure. For example, suppose Libraries and Museums, which are included in Program 4, or Student Support Services, Program 5, or Institutional Support, Program 6, produce services which are consumed directly by clients of the university or of the community at large.[9] This avoids overstatement of total primary program costs which arise from arbitrary inclusion of so-called support program costs which may in fact provide

[8]Since its original formulation, the input/output technique has undergone several refinements and several re-statements. See, for example: Dorfman, Samuelson, and Solow [95], and Lancaster [188].

[9]Such possibilities have been suggested at several points in the literature. One, among many references which make this suggestion, is Gulko [127].

some services directly to clients.[10]

The General Solution Formula

Consider once again the Program Relationship (PR) Matrix presented on pages 153 through 158 Suppose that all of the elements in this matrix, including those in the column "Final Demand" are non-zero, that is, all programs are believed to contribute to all others as well as some "final" outputs also. Then, the ability to generate cost information which is not biased depends upon whether it is possible to devise a computational technique which imposes no artificial assumption on the nature of the production process, i.e., the relationships between programs in the institution. It was shown above that none of the allocational procedures commonly used are capable of dealing with reciprocal relationships, that is, two programs which contribute services to programs which contribute services to each other. Some simple examples were given.

There is a body of theory associated with input/output models which is of considerable assistance in developing a procedure for dealing with such reciprocal relationships.[11]

The PR Matrix, as presented initially above, is an incomplete description of the production process at an institution of higher education for the purposes here. Figure 5-7 on the following page shows a more

[10] This has been done in the past by several studies. Among them are the following: Butter [53], and the Florida Cost Study Committee and the Office of the State Board of Control [111]. Similar restriction of support programs to non-client relationships was done by Ewald and Kiker [105]. This study, which was actually an application of input/output theory, similar to our own, further restricted primary programs to production solely for outside clients; that is, they ruled out the possibility of reflexivity between primary programs and support programs.

[11] The following development is similar to Chapter Nine in Dorfman, Samuelson, and Solow [95].

Figure 5-7

COMPLETE INPUT/OUTPUT MATRIX
FOR AN
INSTITUTION OF HIGHER LEARNING

PROGRAM OUTPUTS
DISTRIBUTION BY USER PROGRAM

PRODUCING PROGRAMS	1. Instruction	2. Organized Research	3. Public Service	4. Academic Support	5. Student Service	6. Institutional Support	Final Demand	Total Output
1. Instruction	A_{11}	A_{12}	......	....	......	A_{16}	x_1	A_1
2. Organized Research	A_{21}	A_{22}	......	....	......	A_{26}	x_2	A_2
3. Public Service	⋮	⋮				⋮	x_3	A_3
4. Academic Support	⋮	⋮				⋮	x_4	A_4
5. Student Service	⋮	⋮				⋮	x_5	A_5
6. Institutional Support	A_{61}	A_{62}	......	....	......	A_{66}	x_6	A_6
7. Labor	R_{11}	R_{12}	......	....	......	R_{16}		R_1
8. Supplies	R_{21}	R_{22}	......	....	......	R_{26}		R_2
9. Plant	⋮	⋮				⋮		R_3
10. Equipment	⋮	⋮				⋮		R_4
11. Land	R_{51}	R_{52}	......	....	......	R_{56}		R_5
Program Total Direct Costs	S_1	S_2	S_3	S_4	S_5	S_6		S^*

*S = Total Institutional Expenditures

complete Leontief table. For simplicity we continue to speak in terms of aggregations at the program level, though actual computations would require that a study begin at least with the subprogram level.

The first six rows and first six columns represent the six program categories as previously. The A_{ij}'s represent that part of the output of the i'th program which is consumed as an input by the j'th program. The seventh column represents the outputs of each program which are consumed by the outside clients of the institution of higher education. The eighth column represents the total outputs of each program. It is easily seen that A_1 equals the sum of elements in row one, or $A_{11} + A_{12} + A_{13} + \ldots + X_1$, and so on for $A_2, A_3, \ldots, A_6$.

Rows seven through eleven represent physical inputs which are directly consumed by each of the programs. These have been divided into labor, plant, equipment, supplies, and land. For simplicity, the sub-matrix formed by elements in rows seven through eleven and columns one through six will be denoted the "Resource Matrix." It will be noted that there is a blank in the seventh column to the right of the Resource Matrix. This is because it is assumed that none of the physical inputs are consumed directly by any university clients. Similarly, the R's shown in the Total Output column represent the total use of respective resources.

To express elements in the Resource Matrix in dollar terms it is necessary to multiply the elements in rows seven through eleven by the appropriate input prices. It is then possible to sum the elements to determine direct program costs. Designating program costs as $S_1, S_2, \ldots, S_6$, it is clear that summing the S_i's gives total expenditures for the period. Similarly, summing across the rows of the Resource Matrix gives the traditional line item budget totals for the period.

In terms of this input/output table, we are interested here in a procedure which will relate the Resource Matrix, the actual resources required to produce the vector of final outputs (for clients) to these outputs in a manner which identifies the total cost associated with each of the outputs. In other words, we are interested in the total and unit costs of elements $X_1, X_2, \ldots, X_6$. Briefly, the relationship is developed in the following way: First, it is necessary to find out how much of each of the program outputs is used as inputs into other programs. In other words, it is necessary to determine costs (in terms of other program outputs) of producing any amount of total output. Second, it is necessary to determine the costs (also in terms of other program outputs consumed) of producing any vector of final demand outputs. Third, the resource requirements for total program outputs must be related to the vector of final demand outputs.

The first step is to determine what amount of each program output must be used up in order to produce any vector of total outputs $A_1, A_2, \ldots, A_6$. It should be noted from the input/output table that the output of each program which is used as an input in all programs (i.e., $A_1 - X_1$) is equal to the sum of the six elements in the row for that program; that is:

$$A_1 - X_1 = A_{11} + A_{12} + A_{13} + A_{14} + A_{15} + A_{16}$$

$$A_2 - X_2 = A_{21} + A_{22} + A_{23} + A_{24} + A_{25} + A_{26}$$

$$\vdots$$

$$A_6 - X_6 = A_{61} + A_{62} + A_{63} + A_{64} + A_{65} + A_{66}$$

At this point it is necessary to translate the A_{ij}'s into some form which allows time to be expressed in terms of total program outputs. Such a transformation enables us to express the program outputs which are required as inputs on the left-hand side of the equations in terms of the total program outputs on the right-hand side of the equations.

This transformation can be derived from the input/output table itself. The table is an exact description of production relationships in effect when final outputs X_1 through X_6 are produced. In fact, reading down the columns of the PR Matrix it is possible to state the total outputs of each program as a function of the outputs consumed from all programs. In other words,

$$A_1 = F_1(A_{11}, \ldots, A_{61})$$

$$A_2 = F_2(A_{12}, \ldots, A_{62})$$

$$\vdots$$

$$A_6 = F_6(A_{16}, \ldots, A_{66})$$

These production functions could be specified further in the following way: Define the coefficients a_{ij} as being equal to the amount of output of

Program i consumed in Program j per unit of output of Program j. Thus, $a_{21} = \frac{A_{21}}{A_1}$ is the output of Program 2 consumed by Program 1, expressed per unit of total output of Program 1.[12] Similarly, by defining coefficients for every element in the PR Matrix it is possible to specify the descriptive production function as follows:

$$A_1 = \left(\frac{A_{11}}{a_{11}}, \frac{A_{21}}{a_{21}}, \frac{A_{31}}{a_{31}}, \frac{A_{41}}{a_{41}}, \frac{A_{51}}{a_{51}}, \frac{A_{61}}{a_{61}}\right)$$

$$\vdots$$

$$A_6 = \left(\frac{A_{16}}{a_{16}}, \frac{A_{26}}{a_{26}}, \frac{A_{36}}{a_{36}}, \frac{A_{46}}{a_{46}}, \frac{A_{56}}{a_{56}}, \frac{A_{66}}{a_{66}}\right)$$

It should be pointed out here that these descriptive production functions represent only the production relationships which are associated with the present level and mix of <u>final demand</u> outputs, i.e., X_1 through X_6. For any alternative level of mix of final demand outputs, these relationships could change. Therefore, <u>cost figures which are derived using such relationships are only appropriate for the level and mix of outputs which we have actually observed in filling out the input/output table</u>. They are not appropriate for predicting the costs associated with a different level or mix of final demand output unless it can be said that the coefficients a_{ij} remain unchanged over the new range of outputs.

These specific production relationships can be used to express the program outputs which are required as inputs to produce any observed vector of outputs. This can be accomplished by substituting for the elements A_{ij} in

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[12] It is important to distinguish between the a_{ij}'s here and the b_{ij}'s used in the text. The coefficients a_{ij} represent production function coefficients. The b_{ij}'s, on the other hand, represent use proportions and are always less than or equal to one. For example: $b_{21} = \frac{A_{21}}{A_2}$. The a_{ij} may be expressed in terms of the b_{ij} as follows:

$$a_{ij} = \frac{A_i}{A_j} \bullet b_{ij}.$$

our first set of equations above, the element $a_{ij}A_j$. In this way we derive the following six equations:

$$A_1 - X_1 = a_{11}A_1 + a_{12}A_2 + a_{13}A_3 + a_{14}A_4 + a_{15}A_5 + a_{16}A_6$$

$$A_2 - X_2 = a_{21}A_1 + a_{22}A_2 + a_{23}A_3 + a_{24}A_4 + a_{25}A_5 + a_{26}A_6$$

$$\vdots$$

$$A_6 - X_6 = a_{61}A_1 + a_{62}A_2 + a_{63}A_3 + a_{64}A_4 + a_{65}A_5 + a_{66}A_6$$

In each of these equations the left-hand side is defined as the total output of Program i which will be used up, i.e., as an intermediate product, in the production of all program outputs. The right-hand side is a formula which quantifies this amount.

It is clear that the six equations above can be expressed through the short-hand of matrix algebra. That is, the left-hand side of the six equations may be expressed as a column vector whose elements are $A_1 - X_1$ through $A_6 - X_6$, the program outputs which must be used as inputs. For this reason we shall call this vector a_I. The right-hand side may be expressed as the product of multiplication of a square matrix by a column vector whose elements are the total program outputs.

The square matrix, denoted as A, is simply the matrix of the coefficients a_{ij}. It will be obvious from the preceding paragraphs that Matrix A can be derived from the PR Matrix in the following fashion: The elements in the first column of the PR Matrix are all divided by A_1, that is, the sum of the elements in the first row. The elements in the setond column are all divided by A_2, or the sum of the elements in the second row, etc. Thus, in matrix terms, the six equations above can be expressed:

$$a_I = Aa$$

where a is the vector of <u>total</u> outputs.

It is now possible to express the program outputs which are necessary to produce a vector of final demand outputs in matrix terms. It has been shown that the amount of each program's output which will be used up in the production of other program outputs is given by the matrix product:

$$Aa$$

where a is the vector of total outputs. Let us define as d the vector of outputs available for final demand, that is, X_1 through X_6. Then d is the vector of total outputs less those "intermediate" outputs used as inputs in other programs. Thus,

$$d = a - a_I$$

or

$$d = a - Aa.$$

Since Ia = a, then,

$$d = (I-A)a,$$

where I is the identity matrix.

Next, in order to solve for a in terms of d, the Matrix (I-A) must be inverted. For this to be possible a condition known as the Hawkins-Simon condition[13] must be satisfied. In essence, this condition is a requirement that the amount of each program's total output is at least as great as the amount which is in turn required as input for all programs. However, in any cost allocation exercise the Matrix (I-A) has been derived from observed flows so this condition is automatically satisfied. Consequently, it is possible to solve for the vector a in terms of the vector d:

$$a = (I-A)^{-1}d,$$

where $(I-A)^{-1}$ denotes the inverse of the Matrix (I-A).

This is an expression relating total outputs to final demand. What is now to be derived is a relationship between total outputs and resources. Referring to the input/output table, the total labor, supplies, plant, equipment, and land resources used in the institution may be found simply by summing across rows seven through eleven. That is,

$$R_1 = R_{11} + R_{12} + \cdots + R_{16}$$

$$\vdots$$

$$R_5 = R_{51} + R_{52} + \cdots + R_{56}.$$

Defining the coefficients m_{ij} as the amount of resource i consumed per unit of output in Program j, i.e., $m_{21} = \frac{R_{21}}{A_1}$, we may re-write this set of

[13] Dorfman, Samuelson, and Solow [95], p. 215.

equations as follows:

$$R_1 = m_{11}A_1 + m_{12}A_2 + \ldots + m_{16}A_6$$

$$\vdots$$

$$R_5 = m_{51}A_1 + m_{52}A_2 + \ldots + m_{56}A_6$$

These five equations may also be expressed in matrix terms. Denote the left-hand side as a column vector,

$$r = (R_1, \ldots, R_5),$$

and the right-hand side as the product of a matrix and column vector a. Denoting the matrix of coefficients as "M," the five equations may be written:

$$r = Ma$$

The above expression relates the total requirement for each type of resource used by the institution of higher education to total outputs.

It is now possible to substitute the earlier expression for total output in terms of final demand, and thus to be able to relate resource requirements to final demand. Since $a = (I-A)^{-1}d$, then

$$r = M(I-A)^{-1}d.$$

In order to express these resource requirements in homogeneous terms, both sides of this equation must be pre-multiplied by a vector of input prices, denoted as w:

$$wr = wM(I-A)^{-1}d.$$

The product wr is a number which equals the total costs of the institution. The above expression states that total costs are equal to the sum of final demand outputs each multiplied by an appropriate average cost. The vector $wM(I-A)^{-1}$ is the vector of average costs of the final outputs. Each element in this vector corresponds to an element in the vector d. The first element, for example, is the average cost of the final output (i.e., that used by clients) from Program 1, Instruction.

It is possible to disaggregate further the components of average costs as follows: The vector wM represents the direct resource costs in dollar terms for each program divided by that program's total output, i.e., direct unit costs. This vector will be called c and the elements in the vector labeled as C_1, C_2, . . . C_6. The average cost of Program j's output for client use is the product of cA^*_j, where A^*_j is the j'th column of the Matrix $(I-A)^{-1}$. In this form it is apparent that the Matrix $(I-A)^{-1}$ yields for each program's final output a vector of weights which are employed to distribute the direct cost components of all programs, the elements of vector c, to the final demand outputs of the respective program of interest. The unit cost formula which is derived above from the general case of an unrestricted production process reveals that each program's final demand outputs are allocated a share of the direct program costs of all programs which supply some intermediate output to it. This feature reflects the fact that no artificial assumptions have had to be imposed on the nature of production relationships between programs.

It was shown previously that when the nature of the production process as represented by the PR Matrix is unrestricted, no computational technique which attempts to allocate costs on a step-by-step basis will yield a solution in a finite number of steps. The procedure outlined here, because it amounts to the solution of six simultaneous equations, provides a single-step means of ariving at unit costs of final program output. It is a theorem that if the Hawkins-Simon condition is satisfied, this method will not only yield a positive result, but also this result will be the limit to which any number of iterations using the "step-by-step" method will approach.[14] The discussion has been in terms of a high level of aggregation, using only six programs to represent all activities in an institution of higher education. In actually applying this technique it would, of course, be necessary to work at a disaggregated level, dividing Instruction according to level--undergraduate, graduate, etc.--and all other programs into subprograms as on page 152 above. Disaggregation increases the data requirements and number of computations involved but does not alter the desireable properties of the General Solution Formula.

It is worthwhile at this point to reconsider the three allocation procedures discussed earlier. Each of them may be expressed as a special case of the general formula above. Such an exercise will dramatize what effect the underlying assumptions of each procedure has on the resulting cost estimates.

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[14]Dorfman, Samuelson, and Solow [95], p. 215.

Consider initially the Simplistic Procedure. The average cost of Instruction, Program 1, final output can be expressed as:

$$AC_1 = \frac{S_1}{X_1} + \sum_{i=4}^{6} \frac{S_i}{X_1}$$

Since $X_1 = A_1$ in the Simplistic Procedure, that is the Instruction program produces no intermediate outputs used by other programs, this expression can be rewritten by substituting A_iC_i for S_i:

$$AC_1 = C_1 + 0 + 0 + \frac{A_4C_4}{A_1} + \frac{A_5C_5}{A_1} + \frac{A_6C_6}{A_1}$$

In other words, the elements of the first column in Matrix A^* are 1, 0, 0, $\frac{A_4}{A_1}$, $\frac{A_5}{A_1}$, $\frac{A_6}{A_1}$. The second column has a second element equal to 1 and 0's for all other elements, and the third column a third element equal to 1 and 0's for all other elements. The assumptions embodied in the Simplistic Procedure, in other words, result in a distribution of all support costs to Program 1. As long as it is assumed that there are no other outputs for the support programs 4 through 6, A_4, . . . A_6 can then be written as A_{41}, . . ., A_{61}. Since all support programs contribute to Program 1, no information is lost. From step two of the general procedure above, the weighting factors $\frac{A_{i1}}{A_1}$ are simply the elements a_{i1} in the matrix of coefficients A, representing the amount of outputs of Program i consumed by Program 1 per unit of output of Program 1. Therefore, the average cost of Program 1 can be written:

$$AC_1 = C_1 + \sum_{i=2}^{6} a_{i1}C_i$$

and the elements of the first column in Matrix A^* are: 1, 0, 0, a_{41}, a_{51}, and a_{61}.

In discussing the Direct Procedure we developed an expression for the total cost of Program 1 of the form:

$$TC_1 = S_1 + b_{41}S_4 + b_{51}S_5 + b_{61}S_6,$$

or, using the definitions of the proportions b_{ij}:

$$TC_1 = S_1 + \frac{A_{41}}{A_4} S_4 + \frac{A_{51}}{A_5} S_5 + \frac{A_{61}}{A_6} S_6.$$

Since X_1 is assumed to equal A_1, the unit cost of Program 1 final output can be written:

$$AC_1 = \frac{S_1}{A_1} + \frac{A_{41}}{A_1}\frac{S_4}{A_4} + \frac{A_{51}}{A_1}\frac{S_5}{A_5} + \frac{A_{61}}{A_1}\frac{S_6}{A_6}$$

Again, since $\frac{A_{ij}}{A_j}$ is simply the coefficient a_{ij} derived earlier, the formula can be written:

$$AC_1 = C_1 + a_{41}C_4 + a_{51}C_5 + a_{61}C_6$$

The Direct Procedure, then, implies a Matrix A^* whose first column consists of the elements 1, 0, 0, a_{41}, a_{51}, a_{61}. The second and third columns have similar form, and $a_{42}, \ldots a_{62}$ and $a_{43}, \ldots, a_{63}$ are not all equal to zero. In terms of the general formula, the Simplistic and the Direct Procedures are very similar. The weights for distributing the costs of the support programs are taken directly from the Matrix of input coefficients, A. Complexities in the production process, the simultaneous interactions among all programs, which make calculation of A^* necessary are all assumed away. The only difference between the two approaches lies in the fact that the Simplistic Procedure assumes $a_{12}, \ldots a_{62}$ and $a_{13}, \ldots, a_{63}$ are all equal to zero.

The Recursive Procedure produced formulas for the total costs of primary programs which can be expressed as follows:

$$TC_1 = S_1 + b_{61}S_6 + b_{51}TC_5 + b_{41}TC_4$$

$$TC_2 = S_2 + b_{62}S_6 + b_{52}TC_5 + b_{42}TC_4$$

$$TC_3 = S_3 + b_{63}S_6 + b_{53}TC_5 + b_{43}TC_4$$

These formulas can be made more explicit in the following two steps: First, determine the total costs, TC_i, of each of the support programs. Second, allocate these to primary programs. This exercise can be exemplified using Program 1, Instruction. Since X_1 is assumed to equal A_1, the expression for the unit costs of Program 1 final output can be written:

$$AC_1 = C_1 + 0 + 0 + a_{41}\frac{TC_4}{A_4} + a_{51}\frac{TC_5}{A_5} + a_{61}\frac{TC_6}{A_6}$$

Since no other programs contribute to Program 6, the total costs of this program are simply the direct costs associated with it. Program 5 total costs, however, consist of direct costs and a portion of the direct costs allocated from Program 6. That is:

$$TC_5 = S_5 + \frac{A_{65}}{A_6} \; 6$$

Similarly,

$$TC_4 = S_4 + \frac{A_{64}}{A_6} S_6 + \frac{A_{54}}{A_5} \left(S_5 + \frac{A_{65}}{A_6} S_6 \right)$$

Finally, by expanding and substituting,the average costs of Program 1 final output may be expressed as:

$$AC_1 = C_1 + 0 + 0 + a_{41}C_4 + (a_{51} + a_{41}a_{54})\, C_5$$
$$+ (a_{61} + a_{51}a_{65} + a_{41}\,[a_{64} + a_{54}a_{65}]\,)\, C_6$$

This expression shows that the assumption that certain of the a_{ij}'s are zero will reduce the expression to the Direct or the Simplistic formula (e.g., if $a_{54} = a_{65} = a_{64} = 0$, in other words, if there are no interrelationships among support programs, the expression becomes that of the Direct Procedure). At the same time, this expression indicates what the bias in unit cost figures might be if one were to use, say, the Direct Procedure at an institution of higher education where the assumptions of the Recursive Procedure were valid.

The Recursive Procedure, thus, does not assume as many of the complexities of production relationships away, and it does get around calculation of the inverse Matrix A^* by allowing step-by-step elimination of support program costs.

The computational steps involved in applying the General Solution Formula can be stated as follows:

Step One: Complete the PR Matrix for the institution using measures or proxies for measures of output.

Step Two: Divide the elements in each column of the PR Matrix by the corresponding row sums. For example, divide every element in column one by the sum of all of the elements in row one, divide every element in column two by the sum of all of the elements in row two, and so on. This operation produces a matrix of input coefficients which we have called Matrix A.

Step Three: Multiply every element in Matrix A by -1.

Step Four: Add 1 to every diagonal element in the matrix produced by Step Three. We have designated the resulting matrix as (I-A).

Step Five: Invert Matrix (I-A).[15] The inverse is designated as A^*.

At this point there are two alternatives. Average costs can be computed in dollar terms or in terms of resource units. In the first case, of course, the answers will simply be aggregated dollar amounts. In the second case, the answer will be expressed in as many unit measures as there are types of resources used.

To determine average costs in dollar terms, the following steps are necessary:

Step One: Determine S_i, the value of resources used directly by Program i, for all programs.

Step Two: Divide each S_i by the corresponding total program output. We designate the result as C_i in this Appendix.

Step Three: To determine the unit cost, in dollars, of Program j, multiply each C_i by a weight which is the corresponding element in column j of Matrix A^*. That is, multiply A^*_{1j} times C_1, A^*_{2j} times C_2, . . ., and A^*_{6j} times C_6. The sum of these products will be the average cost of Program j.

To determine the resource unit requirements of the final demand output for Program j an additional step is needed: List, under the columns of the PR Matrix, the amounts of directly used resources. This produces the matrix which is labeled Matrix M, the matrix of direct resource inputs, into Programs 1 through 6, by the corresponding total program output. To determine the requirement of each type of resource for final demand output of Program j, multiply the elements in the row corresponding to that resource by the weights taken from column j of Matrix A^*.

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[15] Matrix inversion is a straightforward but computationally involved procedure. However, most computer centers have available "canned" inversion programs. If computer time is not available, consult any standard text on matrix algebra, for example Hadley [129].

All of the procedures discussed in the text, Simplistic, Direct, and Recursive, require information which may be conceptually expressed in terms of the Matrix A, as has been demonstrated in the preceding portions of the Technical Appendix. The General Solution Formula, while requiring a more thorough description of the interrelationships among programs within the institution and thus a corresponding increase in data, makes the least restrictive assumptions for cost allocation and might logically be regarded as the standard against which the other techniques are judged.

It should mentioned that the results of the General Solution Formula are automatically expressed in average terms. If total costs are desired, the additional step of multiplying these results by the appropriate number of units is necessary.

Appendix 5-B

SELECTED COST STUDIES AND PROCEDURAL PAPERS CONCERNING COST ALLOCATION

STUDY	PERIOD	PROCEDURE	INSTRUCTIONAL PROGRAM UNIT ALLOCATED TO
Association of Independent California Colleges and Universities. *1970 Statistical Profile, Independent California Colleges and Universities.* Los Angeles, California, March, 1970.	1968-1969 F.Y.[a]	Simplistic	F.T.E. Student[b]
Bartram, John W. "Study of Educational and General Expenditure Per F.T.E. Student by Level for 1966-67." Memo to Administrative Budget Committee. Boulder: University of Colorado, December 1, 1967. (Unpublished)	1966-1967 A.Y.[c]	Simplistic	F.T.E. Student
Butter, Irene H. *Economics of Graduate Education: An Exploratory Study.* Washington, D. C.: U. S. Department of Health, Education and Welfare, Office of Education, Bureau of Research, November, 1966.	Degrees Awarded in 1965	Simplistic	Ph.D. Degree

[a]Fiscal Year (12 months)

[b]Full-Time Equivalent Student

[c]Academic Year (9 months)

STUDY	PERIOD	PROCEDURE	INSTRUCTIONAL PROGRAM UNIT ALLOCATED TO
Campbell, Thomas J. *Program Cost Allocation in Seven Medical Centers: A Pilot Study.* Washington, D. C.: Association of American Medical Colleges and U. S. Department of Health, Education and Welfare, 1969.		Simplistic, Direct, & Recursive	Program Total
Culpepper, J. B. *Current Operating Expenditures by Function, 1962-63, 1963-64.* Tallahassee, Florida: The State University System of Florida, Board of Regents.[d]	1962-1964 A.Y.	Recursive	F.T.E. Student
Duxbury, David A. *Cost Study Manual, 1965-66.* Springfield: Illinois Board of Higher Education, December, 1966.	1965-1966	Direct	S.C.H.[e]
Galbraith, Ralph A. "Syracuse University - 1967-68 Program Cost Analysis." January 23, 1969. (Unpublished)	1967-1968	Recursive	Program Only
Gibson, Thomas Taylor. "Unit Costs of Higher Education: A Study of the University of Colorado." Unpublished Ph.D. Dissertation. Boulder, 1968.	1966-1967 A.Y.	Simplistic	S.C.H.

[d]The procedural manual used for this study was: Florida Cost Study Committee and the Office of the State Board of Control, "A Manual for Analyzing University Expenditures by Function," Revised 1959-60, Tallahassee, Florida. (Unpublished)

[e]Student Credit Hour

STUDY	PERIOD	PROCEDURE	INSTRUCTIONAL PROGRAM UNIT ALLOCATED TO
Hirschl, Harry Hamel. "Some Economic Considerations and a Procedure for a University Cost Study." Unpublished Master's Thesis. Lafayette, Indiana: Purdue University, June, 1965.		Recursive	Class
Illinois Board of Higher Education. "A Unit Cost Study Manual for Non-public Institutions of Higher Education in Illinois." Chicago, August 1969. (Unpublished)		Direct	S.C.H.
Iowa State University of Science and Technology. "Institutional Cost Analysis, 1968-69." Ames, n.d. (Unpublished)	1968-1969 A.Y.	Simplistic	F.T.E. Student
National Committee on Standard Reports for Institutions of Higher Education. *Financial Reports for Colleges and Universities.* Chicago, Illinois: University of Chicago Press, 1935.		Direct	S.C.H.
Ohio Board of Regents. "Actual Institutional and General Expenditures Per F.T.E. 1968-1969." Columbus, n.d. (Unpublished)	1968-1969 F.Y.	Direct	F.T.E. Student
Ohio Board of Regents. "1969-70 Budgeted Expenditures Per F.T.E." Columbus, n.d. (Unpublished)	1969-1970 F.Y.	Direct	F.T.E. Student
Perch, T. James (Director). "A Cost and Profitability Analysis." Bronx, New York: Office of Institutional Research, Manhattan College, June, 1968. (Unpublished)	1967-1968 A.Y.	Simplistic	S.C.H., F.T.E. Student, & Degree

STUDY	PERIOD	PROCEDURE	INSTRUCTIONAL PROGRAM UNIT ALLOCATED TO
Rust, Jerry H. *The Cost of Collegiate Nursing Education in Tennessee.* Nashville: Tennessee Higher Education Commission, 1969.	1967-1968 F.Y.	Recursive	Degree
Technical Committee on Costs of Higher Education in California. *The Costs of Higher Education in California 1960-75.* Berkeley and Sacramento, California, January, 1960.	1957-1958 A.Y.	Direct	S.C.H.
University of Hawaii. "Instructional Unit Cost Study, Year Ended June 30 1969." Honolulu, 1969. (Unpublished)	1968-1969 F.Y.	Direct	S.C.H.
University of Nevada. *University of Nevada System, Cost of Instruction 1968-69.* Reno, n.d.	1968-1969 A.Y.	Simplistic	S.C.H. & F.T.E. Student
University of New Mexico. "Program Budgeting for Higher Education in New Mexico -- A Pilot Study." Preliminary Draft. Albuquerque. (Unpublished)	1969 Fall Quarter Only	Direct	Student Contact Hour

GENERAL SUMMARIES OF COST ALLOCATION PROCEDURES

Association of American Medical Colleges. *Program Cost Estimating in a Teaching Hospital.* Washington, D. C.: Publications Department, Association of American Medical Colleges, n.d.

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McNeely, John H. *University Unit Costs.* Office of Education Bulletin 1937, No. 21. Washington, D. C.: U. S. Government Printing Office, 1938.

Stevens, Edwin B. "The Functions of Unit Cost," *Journal of Higher Education,* Vol. XIII, December 1942, pp. 479-82.

University of Illinois. "Description of the Report Titled 'Selected Resources Applied by a Department to Generate a Student Credit Hour, 1967-68.'" Memo from S. F. Jablonsky to Users of the Selected Resources Analysis. Urbana, March 20, 1969. (Unpublished)

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CHAPTER 6

BASES FOR INDIRECT COST ALLOCATION

Introduction

The allocation of the costs of one activity to the outputs of another is governed by the principle of use. In the case of resource inputs such as labor, supplies, capital and land, distributing the costs of these inputs requires an investigation of their use within organizational units or activities. Input use has been described as the basis for studies of the direct costs of activities. Indirect costs, that is, the costs of supporting activities which are allocated to the outputs of activities supported, require study of how intermediate outputs are used within the institution. This chapter discusses the measurement of intermediate output use by activities within the institution of higher education. The first section below introduces the principle of correlation which guides the selection of proxies for output use and the second section describes proxies which have been used in several institutional cost studies.

Methodology of Output Use Measurement

By the principle of allocating costs on the basis of use, the distribution of any activity's costs is proportionate to the distribution of its output. The percentage of activity i costs, for example, which should be distributed to activity j outputs is given by $\frac{A_{ij}}{A_i}$, the percentage of activity i output used by activity j, where A_{ij} represents the total amount of activity i output used in activity j and A_i represents the total activity i output. If activity outputs were well-defined and their use could be measured, costs could be distributed on the basis of percentages formed in this manner. However, measurement is often simply not feasible. Proxies or substitute measures must be obtained in such cases.

If it is in fact too costly, or at least more costly than it is worth, to monitor actual use of goods and services produced by support activities, then the ideal substitute for this measure is some proxy which correlates closely with use. According to one author, cost should be allocated on some "basis that best portrays its correct expenditure of time, effort and expense."[1] Well-developed statistical techniques exist for measuring correlation. These will not be elaborated here, but the general form of the problem will be explained.

The objective is to allocate costs of one activity to other activities which it supports in some way. Denoting the direct costs of the i'th support activity as S_i, we might express the objective more formally as the selection of a set of explanatory variables, $X_1, X_2, \ldots, X_n$, which systematically explain variations in S_i. Algebraically, the objective is to investigate some systematic relationships, $S_i = f(X_1, X_2, \ldots, X_n)$. Clearly, some algebraic form of relationship must be hypothesized before it can be tested. One possibility is a simple weighted sum, for example:

$$S_1 = a_{i0} + a_{i1}X_1 + a_{i2}X_2 + \ldots + a_{in}X_n$$

There are problems in applying this technique. In the first place, a single institution must have records on the S_i and the explanatory variables. Furthermore, the information must be in comparable form for several periods. In other words, the cost centers or activities from which the S_i are reported and the manner of reporting each of the explanatory variables must be the same in all periods from which data is used. Since organizational structure in institutions of higher education is not constant over time, this requirement may present difficulties. An alternative is to use cross-sectional data, i.e., data which is provided by a number of different institutions for some period in time. However, in this case, the problem of comparability of the measures used becomes even more difficult. Few institutions use the same definitions of activities. Furthermore, measures of the explanatory variables may be defined differently.

The WICHE Cost Finding Principles Project is one on-going study which has potential cross-sectional data available to it. The problem in this

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[1]Evans [103], p. 44.

study, however, is that there are few institutions (at the moment, nine) and at best the "degrees of freedom" which will be available for a regression analysis are very small. The small number of "degrees of freedom" may not allow the determination of any significant effects.

Once a relationship has been hypothesized, candidates for explanatory variables selected, and the relevant information gathered, the relationship can be tested using what are commonly known as "step-wise regression" techniques. Step-wise regression is a means of selecting explanatory variables on the basis of their ability to explain variations in the dependent variable.[2] The step-wise regression is distinguished from other regression models in that variables are included sequentially according to the apparent strength of their relation to the dependent variable. The explanatory variables would be the alternative proxy variables perceived as potential candidates for allocation. The purpose of the analysis is to see which variables appear to have, statistically speaking, the greatest effect upon costs.

It must be borne in mind that the technique described here does not yield a production or cost function in the true sense of the term. Step-wise regression analysis yields an empirically-derived model, not one which is derived logically from behavioral propositions. Therefore, its validity is only as general as the relationships underlying the empirical data themselves. Certainly, the stability of such relationships is an important area for further testing. At present, however, it is not possible to make any more definite statements concerning the proxy measures which are <u>best</u> for explaining variations in costs.

There is no <u>a priori</u> "correct" solution to the problem of selecting explanatory variables for this analysis. However, judgments should be based on some knowledge of the production process for each cost center and the type of service or output which is being provided, as well as the likely users of these services or outputs in the activities supported. The most common type of proxy appears to be some measure relating to users of an activity's outputs. For example, the outputs of the Office of

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[2] For an explanation of step-wise regression techniques consult any standard Econometrics textbook. See, for example, Goldberger [121].

Admissions may be considered as the service of processing applications and admissions for all of the academic departments. While it might be possible to measure in some way the actual service output in terms of the number of documents processed, this may be more costly than it is worth, either in terms of man-hours required to supervise the activity or in terms of the interruption of the normal routine. Therefore, a synthetic measure must be sought and the ideal one is that which approximates most closely use of the Admissions Office service load by each department. One candidate for such a proxy might be the students admitted to departments. If more accuracy is desirable, it may be that students admitted should be weighted by the academic level at which they are entering, or any other measure that might be able to pick up variations in the amount of service load required.

Proxies Used in Institutional Cost Studies

As mentioned above, it is possible to select multiple correlates of use through certain statistical techniques; but because the data requirements of these techniques are high and the costs in terms of analysis are not insignificant, it has been far more common in institutional cost studies to choose a single variable within the user activity with which costs of the support activities are highly correlated.[3]

In cases where only one variable is used, the approach for distributing costs is quite simple. Suppose academic salary is used to distribute costs of some management unit. Then, for each unit in which academic personnel are employed, the total academic salary of the unit is calculated, then the expenses of the administrative unit are prorated on this basis. In other words, if the English Department has a total academic salary bill of \$50,000 and the total academic salary bill of the institution as a whole is \$500,000, the share of the management unit's costs allocated to the English Department is $\frac{\$\ 50,000}{\$500,000}$, or 10 per cent.

Apparently, for most activities, a single correlate has been considered sufficient to achieve the desired accuracy. The single exception

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[3] Apparently this practice is not uncommon in business either. See, for example: Byrne [54], Carroll [61], Malone [198], and Weiss [332].

appears to be "Libraries," where it is common to use several measures in arriving at a proxy for the distribution of library services.

In a review of 26 studies of unit costs at institutions of higher education only 13 were found which involved allocation of indirect costs on the basis of some proxy measure. The chart on the following page (Figure 6-1) presents the proxies which have been used and the frequency of their use for various activities. The rows of the chart show the WICHE subprogram classification of the activities of an institution of higher education. The columns show various types of measures used to distribute costs. The numbers in the matrix show the frequency with which these proxies occur in cost studies reviewed. Appendix 5-B in Chapter 5 contains a list of studies from which this chart was compiled.[4]

The chart shows 11 specific proxies. Clearly, all of these proxies are either users of services and outputs provided by cost centers or measures which can be closely associated with users. For example, total salary is closely associated with total personnel; academic salary is closely associated with academic personnel, and so on. Presumably, either of these two measures would be suitable for estimating services provided by a unit involved in administrative supervision of staff or faculty. Clearly, a variety of measures is used to distribute the costs of each activity within an institution of higher education. However, certain measures do appear to be used more commonly than others. The following paragraphs elaborate on the measures which are summarized in the chart.

Institutional Support. The Institutional Support program was second only to Academic Support in the variety of ways in which costs of its subprograms were allocated forward. Measures used were total operating expenditures, total salary, academic salary, total personnel, full-time equivalent academic personnel, number of students, number of full-time equivalent students, student credit hours, total hours of use, square feet of space, and a formula involving the institution's overhead cost rate for federally-sponsored grants and contracts. It is clear from the

[4]For examples of procedures used in industry, See Black and Eversole [32].

Figure 6-1

OUTPUT PROXY MEASURES FOR COST ALLOCATION

		Total Oper Expen	Total Slry	Acad Slry	Total Pers	FTE Acad Pers	No. of Users	No. of Studs	FTE Studs	Stud Crdt Hrs	Total Hrs of Use	Sq.Ft. of Space	Other
ACADEMIC SUPPORT	Libraries	2	2	2		1	1	2	1	2	1		3
	Museums & Gallery	2	2	2		2			1				1
	Audio Visual Svcs	4	2	2		2			2				1
	Comput Support	4	2	2	1	2			2				1
	Ancillary Support	4	2	2		2			2				
STUDENT SERVICE	Soc & Cultural Develop	2	2	1				1	4	1			
	Supplry Educ Services	2	2	1				1	4	1			
	Cnslg & Career Guidance	2	2	1				1	4	1			
	Financial Aid	2	2	1				1	4	1			
	Student Support	2	2	1			1		4	1	1		
INSTITUTIONAL SUPPORT	Exec Mgmt	6	3	1	1	1							1
	Fin Opers	6	3	1	1	1							1
	General Admin Services	5	4	1		2							1
	Lgstcl Services	6	3	1		1					1		1
	Phy Plt Opers	3	2	1		1					1	5	1
	Fac/Staff Services	4	5	1	1	1							1
	Comm Relat	6	3	1		1							1
	Col.&Dpt Admin	5	2	2		1		1					1

Source: Various full cost studies as listed in Appendix B, Chapter 5.

Note: For a description of the WICHE Classification Structure to the sub-program level see Chapter 5.

chart that the most commonly used proxy was total operating expenditures, with total salaries next and academic salaries third. Within the Institutional Support program it is typical to allocate all subprograms according to the same proxy. In other words, few studies used any more than one proxy to allocate each of the Institutional Support subprograms. Some studies do separate out physical plant operations for allocation on some other basis. By far the most common proxy used for this subprogram was the percentage of total assignable square footage.[5]

It is interesting to note that the most commonly used proxies for service load in management offices appears to be all or part of total operating expenditures in the units being supported. In other words, the underlying judgment appears to be that the management effort in institutions of higher education is more closely correlated with the size of the budget than with the actual numbers of personnel involved.

Student Services. The Student Services subprogram has been prorated on the basis of total operating expenditures, total salary, academic salary, number of actual users of facilities in the subprogram, total number of students, full-time equivalent students, student credit hours, and total hours of use of facilities. As in the case of Institutional Support subprograms, it is possible to identify one proxy which is most frequently used: full-time equivalent students. While the full-time equivalent student measure does appear to be the most logical *a priori* basis for distributing costs of student service activities, it is worth noting that at least as many studies have used all or part of operating budgets. This observation suggests two possibilities: (1) that budget expenditures of a department correlate highly with the number of full-time equivalent student enrollments; and (2) if these two measures are not correlated, total salary or total operating expenditures are measures

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[5]A notable exception to this rule is the procedure recommended by Pinnell and Wacholder [240], p. 30:

> . . . the number of contact hours is the basic planning parameter for teaching space and the number of full-time equivalent (faculty members) is the basic generator of non-teaching space. These basic parameters are developed for each academic department as a part of the process of completing the planning report.

which are more accessible and therefore justify whatever sacrifice in terms of inaccuracy results from using them.

Academic Support. With the exception of the "Libraries" subprogram, activities under Academic Support have been allocated on the basis of total operating expenditures, total salaries, academic salaries, total personnel, full-time equivalent academic personnel, full-time equivalent students, and the institutional research overhead rate. Again, the most commonly used measure appears to be total operating expenditures. However, there is more even distribution among the measures used here than for the previous program. Where total salary, academic salary, full-time equivalent academic personnel, and full-time equivalent students are concerned, it may be a matter of indifference as to which of these measures can be considered best. If academic staffing is based on a faculty-student budgeting formula, then full-time equivalent students will simply be proportional to academic personnel and both will correlate equally well with the costs of the supporting activities. Similarly, where academic salaries make up the large portion of total salary bills in departments, these two measures can be expected to be highly correlated.

The subprogram "Libraries" is worthy of separate mention because of the more elaborate treatment which is typically given to the allocation of library costs. For this purpose at least 12 different measures have been used, and none really stands out as the single most important proxy. The "Libraries" subprogram is one of the few whose costs are frequently distributed on the basis of more than one proxy. One study has identified a number of variables not included here in measuring library use.[6] Another has been proposed to determine weights for measuring differential library use by students of different academic, financial, and marital status.[7] A third study which allocated library costs on the basis of student credit hours differentiated the credit hours according to research, non-research, or special study in order to determine differential use factors.[8] A similar approach

[6] Quatman [245].

[7] Alden [5].

[8] Roberts [249].

has been used in a recent study of the costs of collegiate nursing degrees.[9] In an unpublished model for institutional cost analysis, the University of Kentucky allocated 50 per cent of library costs on the basis of student credit hours and distributed 40 per cent to Organized Research and 10 per cent to Public Service in order to allocate library costs to instructional programs.[10] The University of Nevada divided library costs into: (1) processing and purchasing costs--which were allocated according to the number of volumes required by each department; and (2) circulation and maintenance costs--which were allocated according to departmental enrollments.[11]

Conclusion

To summarize, total operating expenditures or salary expenditures of organizational units appear to be the most common bases for allocating costs of support activities. However, as mentioned above, for purposes of allocating support costs to instructional activities there may not in fact be significant differences between the correlation of support costs with total operating expenditures of the unit served and the other measures mentioned. As long as faculty staffing is related to enrollments by means of a formula and if the mix of high and low salaried faculty members is fairly similar over departments, then all of these measures may in fact be highly correlated. If so, use of any one of them is a matter of indifference, and the selection of proxy measures should be based ultimately on ease of computation and availability of information.

It is interesting to observe in this respect that the measures which one might expect to yield the most accurate measures of use occur infrequently. Number of users, for example, and total hours of use have been used only for facilities where monitoring users might be an ordinary part of charging for services. "Student Support" facilities, "Libraries," "Logistical Services," and "Physical Plant Operations" are the only subprograms

[9] Rust [257].

[10] University of Kentucky [317].

[11] University of Nevada [318].

in which these measures have been used and they do not appear to have been used very frequently. This point suggests that the costs of monitoring actual use are prohibitive or at least not worth the added accuracy.

One advantage of using the step-wise regression technique described earlier in order to select proxies is that the correlation between all of these measures will become very evident. High correlation between all of the proxies would eliminate the need for anything more complicated than a single measure base for prorating support costs to user activities. Unnecessary costs of gathering information and computing complicated weights might be avoided where the results of regression analysis indicated that a single independent variable provided as much explanatory power as a combination of multiple variables.

CHAPTER 7

ALLOCATION OF RESEARCH COSTS

Introduction

The cost allocation methodologies described earlier are techniques for allocating indirect costs--that is, costs of "support programs"--forward to "primary programs." It was assumed that primary programs produce "final" outputs, that is, outputs for consumption by clients of the institution: students, or society at large. However, it is probably true that no primary program is exclusively a producer of final outputs. The programs which have been identified as Instruction, Research, and Public Service may all provide services to each other as well as final output. To the extent that such interrelationships among the primary programs exist, total cost for these programs under a correct allocation procedure should include portions not only of costs of support programs, but also of other primary program costs.

It appears that some of the most difficult questions concerning these interrelationships arise with respect to the Instruction and Research programs. First, the joint product nature of activities in these two groups makes the distinction somewhat arbitrary and possibly difficult to maintain in sorting budgetary accounts. Research and instructional outputs are jointly produced by faculty members, support staff, equipment and capital, as well as by graduate students who are involved in both processes. According to William Bowen:

> A basic difficulty is that in many instances there is no clear division between time spent teaching (particularly if it is graduate teaching) and time spent doing research.[1]

Second, once the inputs and costs are separated for the two programs, it remains to be determined which of the research outputs are used in the

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[1]Bowen [38], p. 55.

instructional process, and vice versa.[2] One author has put it this way:

> . . . some may feel that student instructional expenditures include too much because some faculty research (included in instruction and departmental research) does not benefit students. On the other hand, too little may be included if some organized research expenditures do benefit students or make it easier to hire faculty.[3]

In other words, even if an acceptable set of definitions of activities comprising the Research and Instruction programs can be determined, there are two basic problems to be solved: (1) determination of the direct costs of these activities; and (2) determination of the outputs of the activities and how they are used.

With little doubt, every institution of higher learning is to some degree unique. Each has its own goals and its own comparative advantage in certain fields, and these will be reflected in different program interrelationships. In particular, different institutions will emphasize different kinds of research and maintain different mixes of research, as well as graduate and undergraduate instructional activity. Differences in emphasis would surely be expected, for example, where there are differences in the mix between public and private financing of research activities. Differences within public support of the mix between federal, state and local sources would also be reflected in the nature of the research and instruction outputs. Consequently, assessment of proportions of inputs and outputs used by the two programs will not be universally valid. On the other hand, it is both possible and necessary to determine conceptual guidelines for deriving these proportions in the context of a cost allocation exercise at an institution of higher learning.

The problems of defining activities and measuring direct costs have been discussed earlier. Chapter 4 contains a list of primary program activities which have either instructional or research outputs. As was pointed out, since the multiple output problem does not necessarily inhibit

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[2]According to Millett in [204], p. 94:
Research planning has little if any validity, however, unless some determination of measurable results can be made.

[3]O'Neill [230], p. III-6.

activity classification, it is possible to adopt classifications on the basis of primary intent of funders or clients without precluding the possibility of accurate cost allocations. Activities for which the primary intent is clearly the transfer of knowledge from professor to student can be included in the instructional program. Activities for which the stated primary intent is clearly the creation of knowledge or the application of knowledge to a given problem can be included in the research program.

For many activities, however, identification of primary intent as either instruction- or research-oriented is not easily accomplished. In these instances assignment of the activities to either instruction or research programs may be somewhat arbitrary. One method is to assign activities to programs on the basis of primary intent. It must be emphasized first that assignment of activites to major programs is not the same as allocating costs. Assigning activities to major programs is simply for the purpose of developing a program classification structure that includes all activities. Allocation of the costs of one activity to another depends entirely on a comprehensive review of how the various outputs of each of the activities are used within the institution of higher education. Second, whatever assignment is made, it should be clear that the classification according to primary intent or any other single measure does not imply that outputs or benefits of only one dimension being produced.

The purpose of the present chapter is to determine conceptual guidlines and current methods for allocating some portion of research costs to instructional outputs. As in previous chapters, the principle of output use is recommended as a basis for determining allocable costs. The first section below deals specifically with the problem of identifying the outputs of various instructional or research activities and the problem of determining primary intent. The second section addresses the problem of determining output use. The third section describes four alternative techniques currently used for measuring output use among instructional and research activities and the allocation procedures which they lead to.

Outputs and Primary Intent of Instruction and Research Activities

It is helpful for many reasons to discuss cost allocation in terms of a uniform program classification structure. The WICHE Program Classification Structure has already been used as a framework for discussing allocation of indirect costs in institutions of higher education. However, the present discussion of primary program activities requires somewhat more detail than is currently available in the WICHE structure. Consequently, a list of six activities which can be described as instructional, research, or support of either has been prepared after a comprehensive review of recent literature concerning faculty activity analysis.

In order to make this list of activities consistent with the general form of the WICHE Classification Structure, each activity must be assigned to the Instruction, Research, or Academic Support program. In cases where outputs of an exclusively instructional or exclusively research nature are produced there is no problem. However, many of the activities clearly have multiple outputs which are both instructional and research in nature. In order to fit such activities into the WICHE Classification Structure they may be assigned according to designation of primary intent. Again, it must be emphasized that grouping activities within a classification structure is not the same as allocating their costs.

The activities concerned are listed in Table 7-I on the following pages, along with the commonly acknowledged outputs.[4] Each output is classified as Instructional (I), Research (R), or both (I/R), or Support (S) in nature. Finally, current generally accepted practice as to the designation of the primary intent of the activity is indicated.

This table is based on a comprehensive review of the literature concerning relationships between Instruction and Research. The problem of identifying primary intent is, to be sure, not an easy one. For most of the activities described, the literature is not without divergent views.

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[4] Since relationships between Instruction and Research programs are of major concern here, a third primary activity and program, Public Service, has been left out to simplify the exposition.

Table 7-I

OUTPUTS AND CURRENT PRACTICE AS TO DESIGNATION OF PRIMARY INTENT OF FACULTY ACTIVITIES[a]

Activity	Output	Nature of Output	Primary Intent of Activity
1. Graduate Instruction			
a. Classes	Credit hours	I	I
b. Student Research & Thesis Work	Training in the conduct of research	I/R	I[b]
c. All Related Activities	Support of classes	I	I
2. Undergraduate Instruction			
a. Classes	Credit hours	I	I
b. Student Research & Thesis Work	Training in the conduct of research	I/R	I[b]
c. All Related Activities	Support of classes	I	I
3. Instructional Services (All Activities)	General support for all classes and thesis activity	I	I
4. Departmental Research			
a. Maintenance of professional standing	Benefits to classes and to research projects	I/R	I

[a]Primary intent of activities which produce outputs of both an instructional and research nature is made according to current practice as evidenced in the literature.

[b]As distinct from the type of student research work identified under 5c.

Table 7-I (Cont.)

Activity	Output	Nature of Output	Primary Intent of Activity
b. Faculty research	Contribution to stock of knowledge in the public domain; appreciation in research skills; appreciation in teaching skills	I/R	I[c]
5. Organized, Sponsored, Contract Research			
a. Without students or regular teaching faculty engaged	Contribution to public stock of knowledge; physical outputs; patents	R	R
b. Without students but with regular teaching faculty	Contribution to public stock of knowledge, physical outputs; patents; appreciation in marketable research capability; benefits to classes and appreciation in marketable teaching capacity	I/R I/R	R R
c. With students	(Same as above); appreciation in marketable student skills	I/R	R
6. Departmental Administration			
a. Student-related administration	Services to students	S	S
b. Faculty-related administration	Services to faculty	S	S
c. Internal assigned studies	Research on internal activities and problems	S	S

[c]The literature is virtually unanimous in designating the primary intent of this activity as instruction. However, we feel that since the results of such research do go into the public domain and since currently-enrolled graduate students are only one group of beneficiaries of such public goods, that it would be more appropriate to designate primary intent of this activity as research.

Concerning primary intent, for example, Miller has stated:

> The practice of combining the costs of instruction, research, and public service, instead of reporting each of them separately is subject to question. Research and public service are not instructional activities, nor are they supporting activities in the same sense as the operation of the library or the operation of the physical plant. The practice causes severe distortions of the apparent cost of "teaching" in some fields.[5]

On the other hand, Mishan argues:

> Certainly the time and effort spent in Research is not, in the long run, separable from university education. For the advance of knowledge . . . is ultimately passed on to the student himself.[6]

In other words, there is a divergence of views in the literature concerning the extent to which Research can be considered an activity which supports the instructional process.[7]

If there is disagreement concerning the extent of the relationship between Research and Instruction, the majority opinion does appear to be that the primary intent of separately budgeted research projects is the production of some research output which has additional social value quite apart from its contribution to instruction. Millett has observed that:

> Research cannot be indifferent to the possibility of practical need. . . . [S]ocial support of research activity will tend to be most generous when practical need is the major objective of research planning.[8]

In fact, the development of research projects in response to outside needs as opposed to internal academic needs has lead to some of the stronger criticisms of federally sponsored research in higher education. Money for research, says one author:

> . . . places an unhealthy monetary lure before the staff which may well result in specific research projects being selected for reasons of economic record rather than, as

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[5] Miller [203], p. 99.

[6] Mishan [206].

[7] Other sources which discuss the relationship between Instruction and Research are: American Society for Engineering Education [9], Bowen [38], Gottlieb [122], Kidd [179], and Lukasiewicz [194].

[8] Millett [204], p. 95.

> should be the case, on the basis of intrinsic intellectual or academic merit.[9]

Evidently, the intent of outside funders of research is seen by some sources as being a pernicious influence on the academic community precisely because it is motivated by other than academic or intellectual needs.[10]

Indeed, if one can accept the stated intent of sources of funds, research sponsored by the federal government is performed primarily to solve some problem of specified scope and focus to the direct benefit of the funding agency.[11] The major criterion for acceptance of proposals by the Public Health Service, for example, appears to be "scientific excellence and relevance to Public Health Service program goals."[12] These goals are rather broadly defined as assisting:

> . . . public and other non-profit institutions and individuals to establish, expand, and improve research activities in the Health Sciences and related fields.[13]

Rights to whatever specific and identifiable outputs are produced are reserved for the Public Health Service itself.[14] The Public Health Service is explicit that the only costs allowable for charging to the grant are those in payment for inputs used in the course of the project. In particular, a distinction is carefully made between student activities which may be considered training, and those which may be considered employment

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[9] Weaver [329], p. 62.

[10] One study has been undertaken specifically to guide institutional response to this problem; see Cagle [55]. See also Kidd [180]; Kidd traces the federal government-university partnership in research, particularly since World War II and the pertinent problems arising from this relationship. See also Nisbet [226].

[11] See, for example, Staats [275]. Also, Kidd, op. cit., has pointed out that the federal government buys research to secure answers that various federal agencies want and therefore supports those research centers best able to do so, which means the basic research interests of established university groups and centers have a comparative advantage in this field.

[12] H.E.W. [305], p. 1.

[13] Ibid.

[14] Ibid., p. 5.

services.[15] Evidently, the Public Health Service sees its mission primarily as supporting research which benefits the community at large. The National Science Foundation and Department of Defense policy statements are similar in specifying primary intent as support of socially valuable research.[16]

Based on such views, the Organized Research activities are all classified in Table 7-I as being research in primary intent. It should be clear from the foregoing paragraphs, however, that this classification is based on stated primary intent. In this light the classifications listed in Table 7-I should be treated with some caution and should by no means be considered a substitute for the kind of thorough analysis of actual output use within the activities of the primary programs which should be considered necessary for cost allocation. [17]

In addition, it is worth mentioning that at least one source has recommended the formation of a separate program, entitled Instruction/Research, to include all activities which result in joint instructional and research outputs.[18] The merits of such a proposal probably depend on the manner in which individual institutions of higher education choose to administer the activities which are candidates for inclusion in the Instruction/Research program. Operationally speaking, it may involve more confusion than it is worth to maintain a separate account for these activities if there is no already existing separate budgetary unit or office with responsibility for these activities. Also, since most accounts classified as Instruction in institutions of higher education do usually result in joint instructional and research outputs, these programs are in essence Instruction/Research and it may not be useful further to segregate activities with exclusively instructional

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[15] H.E.W. [305], p. 27.

[16] National Science Foundation [222], pp. 1, 2, and 14. See also: U. S. Congress [302], p. 59; U. S. Office of Naval Research [313], p. 1; and and U. S. Department of Defense [304], p. 9, para. 13.

[17] One study does exist which has traced the development of certain medical advances from years of sponsored research projects at institutions of higher education: Illinois Institute of Technology Research Institute [162] and [163].

[18] Henle [143].

outputs. Once again, it must be pointed out that creation of such a joint output program is not necessary for costing the outputs, or allocating costs to other programs. This problem exists independently of how activities are classified and depends for solution on the extent to which outputs may be defined, evaluated and their use measured.

One final word of caution is in order. It is virtually impossible to generalize the extent to which research and instructional activities do interact across programs in institutions of higher education. The fact that separately budgeted research is more likely to be a factor in the Natural and Social Sciences than in the Humanities, for example, suggests that there will be a fundamental difference in the research/instruction relationships of programs within these categories. Furthermore, there may be certain aspects of research techniques in lab sciences which make the relationship between Instruction and Research in such programs uniquely different from that in the other Natural Sciences and the Social Sciences. The uniqueness of these relationships makes it difficult to speak in terms of aggregates. There is no single interrelationship which has general validity for all departments or schools within the institution. While numerical examples are given at the end of this chapter in order to illustrate differences which result from various allocation techniques, the purpose of these examples is most emphatically not to suggest that a single university-wide percentage rate can be applied to research program costs in the allocation of these costs to instructional outputs.

Determining How the Intermediate Outputs of Instruction and Research Activities are Used

The problem of quantifying program interrelationships at an institution of higher education requires measurement of outputs and identification of users. We must know to what extent instructional outputs are used as inputs into the research program and vice versa. The list below exemplifies activities which may provide service to more than one user activity:

1. Basically instructional activities which result in outputs used by the Research program (probably minor):
   a. Graduate Classroom Seminar Discussion--may focus on problem of research interest to faculty.

b. Graduate Assignments--may be "papers" which the faculty member assigns to address general dimensions of a research problem he is interested in.

c. Thesis Supervision--may involve work with a graduate student who, while not officially connected with a research project, has picked a topic very significantly related to problem involving the faculty member--thus resulting in some direct input into the research project.

2. Basically research activities which result in outputs used by the instructional program:

a. Research Project--may result in valuable training experience and/or formulation of thesis topics for one or more graduate students.

b. Development of new techniques or equipment (e.g., for laboratory work).

Spillover Benefits of the Instruction and Research Activities

While it may be impracticable, if not impossible, to isolate either the joint products which result from these activities in institutions of higher education, or their beneficiaries, there seems to be acknowledgement that such benefits do exist. Spillover benefits and joint products of instructional activities have been discussed earlier.[19] In addition, there are similar benefits to instructional activities from research activities.

In order to allocate research costs to outputs of instructional activities, closer attention must be paid to the actual spillover benefits which occur in order to determine those which might be viewed as a basis for allocating costs. Spillover benefits for students directly involved in research activities at an institution of higher education consist not just of the monetary payment made for the student's time working on a project, but also of a stream of future gains arising from the fact that special experience given by the project makes the student a more valuable professional. Work on projects may even be an explicit degree requirement.

[19] See Chapter 2.

In general, it might be argued that competition for research assistantship positions means that no student is able to get monetary compensation for his labors that is any greater than the value of his contribution to the project. Consequently, both the monetary payment and the non-monetary benefits, that is the appreciation in the value of student skills, must be viewed as two parts of compensation for services rendered. Othing things being equal, the existence of the non-monetary benefits which accrue to the student will mean that he is willing to accept a lower amount of monetary compensation than he would in the absence of the non-monetary benefits. One might compare the salaries of the research assistants with those of comparable individuals outside of the university to test this notion. In cases where appreciation in student skills can indeed be considered part of the payment for student services rendered, then the existence of these spillover benefits is not in itself a basis for the treatment of other research costs as part of the instructional program.[20] Furthermore, to use the existence of this type of benefit as a basis for the requirement that institutions of higher education bear some portion of the costs of research may actually result in a form of double charging. If students in effect pay for the appreciation in their skills by accepting lower research salaries, the requirement that they, and/or other sources of instructional funding, share total costs of research grants will result in overpayment for these benefits.

On the other hand, in cases where the services rendered by graduate assistants are of little value and relevance in the eyes of funders and the intent of a grant is indeed to support graduate study in a particular field, support of graduate students does amount to a subsidy. In these cases, the total portion of such funds made up by research assistant salaries might be considered an instructional cost. Typically, however, such subsidies occur in the context of training grants (as opposed to research grants), the total costs of which can be attributed to instruction.

In addition to the spillover benefits which affect students directly, that is by their participation in research projects, there are benefits which affect students indirectly. First, access to new knowledge and to inventions or new materials developed in the course of research projects can

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[20] U. S. Bureau of the Budget [300].

enhance instructional programs at the host institution. In particular, participating faculty members may become more highly valued professors as a result of participation in research projects. Such benefits to the instructional capacity of the institution also appear to have been used as a rationale for the requirement that institutions share the costs of separately budgeted research projects.[21] However, as in the case of students, competing faculty members are likely to pay for the additional value--in terms of skills and knowledge they acquire from conducting research projects--by accepting lower wages than they would in the absence of such benefits. Thus, adherence to standard cost sharing requirements may again involve double charging in the case of these benefits, as in the case of benefits which accrue directly to students.

Conceptual Illustration of Output Use

Use of activity outputs within primary programs may be summarized in diagrammatic form by means of an input/output framework similar to that used to explain indirect cost allocation. The matrix of Figure 7-1 on the following page illustrates the six categories into which activities of primary programs have been grouped previously. Activity definitions are listed across the top and down the left-hand side of the matrix. Listings across the top include a column for outputs used by the ultimate clients of the institution of higher education. At the bottom are rows designating the costs of each activity, including the direct costs, the allocated indirect costs from all overhead programs, and the sum of these two items, labeled here, "Total Primary Activity Costs." Where there are clients for the outputs of activities a check is made in the Final Output column; all other outputs are shown by the appropriate intersection of row and column. Each row indicates the "producer activity" and the column indicates the "user activity."

On Figure 7-1 checks have been placed in the intersection of a row and column to indicate that the particular row activity produces outputs which may be used in the activity designated by the respective column. Beginning with the last activity, Departmental Administration, it will be

[21] U. S. Office of Management and Budget [312], p. 2.

Figure 7-1

PRIMARY ACTIVITY INTERRELATIONSHIPS

	Graduate Instruction	Undergraduate Instruction	Instructional Services	Departmental Research	Organized Research	Departmental Administration	Final Output
1. Graduate Instruction				X	X		X
2. Undergraduate Instruction				X	X		X
3. Instructional Services	X	X					
4. Departmental Research	X	X			X		X
5. Organized Research	X	X		X			X
6. Departmental Administration	X	X	X	X	X		
Direct Costs							
Indirect Costs							
Total Primary Activity Costs							

noted that there are checks in columns one, two, three, four, and five. These checks indicate that administrative activities provide support services for Graduate Instruction, Undergraduate Instruction, Instructional Services, and Departmental and Organized Research. Since Departmental Administration services do not reach clients of the institution directly, that is, they only support the primary activities designated, there is no check in the column under Final Outputs. The next two rows are the Organized Research and Departmental Research activities. As suggested in the list above, there may be some contribution of these two Research programs directly to the instructional process. Therefore, checks have been placed in the first column and the second column of these two rows. In addition to the instructionally-related output of Research programs, there is quite clearly some research output for clients of the institution, over and above the current student body (e.g., a net addition to the stock of knowledge). Therefore, checks have been placed in these two rows under the Final Output column. Thirdly, it is possible that the Departmental Research activity may provide some direct assistance to Organized Research activity and vice versa. To indicate this possibility checks have been placed at the intersections of these two activities. The Instructional Services activity has been defined basically as a collection of services which give all of their support to instruction. Therefore, the only check in this row is under the first two columns. Finally, the Graduate and Undergraduate rows have three checks. For obvious reasons there are checks in the Final Output column designating the output of educated students. The other checks indicate the above-mentioned possibility that courses, lectures, or seminars may have some direct benefits for faculty involved in Research programs.

Having identified activities and conceptually defined their outputs as well as the users of these outputs, the next step is to show how this information might be used for determining the costs of graduate education. While difficult to quantify, it is generally acknowledged that research activity contributes something to the instructional process. Ideally, if it were possible to quantify this contribution and to attach a value to it and also to quantify the other values of research (e.g., additions to the public stock of knowledge), these values could be used to allocate some research costs to the instruction process.

Current Alternatives in the Measurement of Use Proportion

In the absence of output measures and values, several other possibilities exist for assigning some fraction of Research activity costs to Instruction. These are described below, and two alternatives are illustrated in terms of the input/output chart above. The last chart contained checks to indicate possible use of the activity's outputs by another. Alternatives described in this section show how the checks might be replaced by actual proportions which are implied by the use of the different estimating techniques. Appendix 7-A Contains numerical examples of each alternative.

Alternative 1: Survey of Faculty Involved in Joint-Output Producing Activities

One alternative which is attractive because it might be carried out as part of an on-going faculty activity analysis, is to determine use proportions on the basis of judgmental assessments by faculty members engaged in the activities which produce joint outputs. In this case, the faculty activity analysis would involve two types of questions. The first, and more traditional type of question, would ask the faculty member to estimate the proportion of time spent on the various activities. The second type of question would ask the faculty member to indicate for those activities which have joint instructional and research outputs, how the joint outputs are used (i.e., by students or not) and what proportion should be assigned to student consumption.

Obviously, there are problems inherent whenever subjective judgment is substituted for objective measurement; but in an area which really appears to defy objective measurement, personal judgments may be the only reasonable substitute. Furthermore, personal judgment has long been the chief means of estimating the distribution of faculty input to various activities and may be no less valid when it is used to determine the distribution of outputs from these activities. One variation of this approach has actually been used at the University of California.[22] The California analysis essentially relied exclusively on faculty judgment to determine

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[22] University of California [315].

output use. However, this study did not require that faculty determine proportions of use when a particular output was used by more than one activity.

Another variation of this approach was used by Irene Butter in her study, *The Economics of Graduate Education: An Exploratory Study.*[23] Butter used the ratio of faculty hours spent on thesis supervision to faculty hours spent on sponsored research projects as an approximation of the ratio in which organized and sponsored research outputs are used by instructional and research activities, respectively. While Butter's method focuses on inputs, it does demonstrate the usefulness of faculty activity analysis data for this particular purpose. It seems likely, therefore, that this alternative would prove to be a worthwhile possibility for institutions which already have an established faculty activity analysis procedure.

Alternative 2: Revenue as an Indication of Research Cost

The second alternative lumps both the Departmental and Organized Research activities together and allocates a portion of their total activity costs to the instructional activity. The portion allocated is found by subtracting out all revenues from separately budgeted research grants or contracts which are specified as being for the purpose of research.

Alternative 2 is illustrated in Figure 7-2 on page 216. First, Departmental Administration is prorated over the appropriate departmental activities, and Instructional Services costs are allocated entirely to instructional activities. For ease of exposition, any contribution of Instruction to Research is ignored and 100 per cent of the costs of Graduate and Undergraduate Instruction are registered in the Final Output column. Both types of research activity are treated as a unit. The proportion of total research costs assigned to the instructional activity, P, is determined as follows:

$$P = \frac{(C_4 + C_5 + C_{4,6} + C_{5,6}) - R}{(C_4 + C_5 + C_{4,6} + C_{5,6})}$$

where R represents the grant and contract revenue specified for research purposes, and $C_{4,6}$ and $C_{5,6}$ represent the portions of Departmental Administration

[23] Butter [53].

Figure 7-2

USE PROPORTIONS -- Alternative 2

<table>
<tr><th></th><th>Graduate Instruction</th><th>Undergraduate Instruction</th><th>Instructional Services</th><th>Departmental Research</th><th>Organized Research</th><th>Departmental Administration</th><th>Final Output</th></tr>
<tr><td>1. Graduate Instruction</td><td></td><td></td><td></td><td></td><td></td><td></td><td>100%</td></tr>
<tr><td>2. Undergraduate Instruction</td><td></td><td></td><td></td><td></td><td></td><td></td><td>100%</td></tr>
<tr><td>3. Instructional Services</td><td colspan="2">100%</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>4. Departmental Research</td><td rowspan="2">G·P</td><td rowspan="2">(1-G)·P</td><td></td><td></td><td></td><td></td><td rowspan="2">(1-P)</td></tr>
<tr><td>5. Organized Research</td><td></td><td></td><td></td><td></td></tr>
<tr><td>6. Departmental Administration</td><td>(%)</td><td>(%)</td><td>(%)</td><td>(%)</td><td>(%)</td><td></td><td></td></tr>
<tr><td>Direct Costs</td><td>D_1</td><td>D_2</td><td>D_3</td><td>D_4</td><td>D_5</td><td>D_6</td><td></td></tr>
<tr><td>Indirect Costs, previously allocated</td><td>I_1</td><td>I_2</td><td>I_3</td><td>I_4</td><td>I_5</td><td>I_6</td><td></td></tr>
<tr><td>Total Primary Activity Costs</td><td>C_1</td><td>C_2</td><td>C_3</td><td>C_4</td><td>C_5</td><td>C_6</td><td></td></tr>
</table>

costs allocated previously to Departmental and Organized Research. The proportion of costs assigned to outputs which are used by clients over and above the currently-enrolled students (e.g., additions to the public stock of knowledge) is simply (I-P), or the total recovered costs of the research projects. If G represents the portion of instructional costs assigned to Graduate Instruction and (1-G) represents the proportion assigned to Undergraduate Instruction, then the proportions of research costs allocated to Graduate and Undergraduate Instruction respectively are G•P and (1-G)•P.

Like Alternative 1, Alternative 2 does attempt to take into account the fact that even Departmental and Organized Research activities involving faculty and students have outputs which are of value above and beyond their instructional value. However, this is done by using only the recovered research costs to approximate the costs attributable to the final non-institutional output. There is some precedent for this practice, at least with respect to federal agencies. It is the position of federal funders that the cost sharing or unrecovered costs on federally-sponsored research projects represent acknowledgement of the fact that benefits accrue to other clients of the institution as a result of the institution's participation in research projects.[24]

Federal policy on cost sharing reflects the view that if there are benefits other than the research output which it is the purpose of the funding agency itself to support, these should be accounted for either on an individual project or an aggregate basis by having an appropriate share of the actual research costs to the institution be borne by other clients of the institution. In cases where cost sharing may be interpreted as an accurate measurement of benefits to other clients of the institutions of higher education, it would seem proper to allocate some of the actual research costs to other primary programs on this basis. However, as mentioned earlier, spillover benefits resulting from research projects may already be taken into account by the fact that the research can be conducted at lower cost than in the absence of those benefits. These lower costs, which

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[24] With respect to the amount of cost sharing, the intent appears to be to reflect the extent to which the institution itself benefits. See U. S. Office of Management and Budget [312], pp. 2-5. See also National Science Foundation [221].

are a result of competition among students and faculty who stand to gain from participation in research projects would therefore obviate the necessity for cost sharing.

Since the federal government does bargain with institutions of higher education from a monopoly position, it is in a position to insist upon cost sharing as a requirement for doing business. If it does so, it may enforce the kind of double counting described above. As a result, use of Alternative 2 will result in an understatement of research costs and an overstatement of instructional costs by the amount of the double counting.

One of the few institutional studies which does attempt to take account of the relationship between research and instruction functions and tries to measure the contribution of Research to Instruction has been done by Hirschl.[25] Hirschl divided all expenses between the instruction function and the research function, then assumed that the proportion of Research expense not explicitly covered by the grant and contract revenues, both direct and indirect, measured that portion of research activity which could be considered an input to the instructional function. Hirschl thus used the alternative described here, which amounts basically to allocating unrecovered research costs to Instruction.

Alternative 3: Use of Synthetic Proportions

A third possibility is to determine use proportions "synthetically," that is, to manufacture a proportion by looking at the relative volumes of expenditure on activities with purely instructional and purely research outputs. Table 7-I on pages 203 and 204 has identified activities and their outputs and has classified outputs according to whether they are Instructional, Research, some type of joint product, Instruction/Research, or Support. In order to synthesize a proportion on which to base distribution of total primary activity costs, one might proceed as follows: First, aggregate all of those activities which have solely instructional outputs. Denote the total primary activity cost of the former group as C_I and that of the latter group as C_R. The remaining total primary activity costs are thus the costs of the activities which produce joint Instructional and Research

[25] Hirschl [151].

outputs, which may be denoted $C_{I/R}$. The problem now is to break up $C_{I/R}$ and allocate it to the two separate output-producing activities, Instruction and Research.

A proportion for distributing $C_{I/R}$ may be synthesized by forming the ratio $\frac{C_I}{C_R}$. This ratio may then be used to distribute the costs of all the joint-output producing activities to the separate Instructional and Research producing activities. Obviously, this alternative is not based in any sense on measurement of use and for this alternative to be valid it must be true that use of the outputs of the joint product activities is somehow proportional to the expenditures on activities which produce solely instructional and solely research outputs. For this reason the proportion derived above is called "synthetic." If this proportion is determined on an aggregate basis and a single ratio used for all departments to distribute costs of joint-output producing activities, there is certainly reason to question the validity of the results. However, if the operation is performed separately, say by discipline groups, the results may be somewhat less arbitrary. Even if the third alternative results in an overstatement or understatement of the absolute level of instructional costs, it may provide reasonable estimates of the relative costs among departments.

A second possibility for approximating synthetic proportions might be to compare the academic labor costs at institutions which are all instructional and all research. For example, average faculty salary at a liberal arts four-year college might be compared with the average salary of research personnel in corporations such as Rand or Battelle in order to derive some synthetic weight.

Alternative 4: All Research Involving Faculty or Students is a Cost of Instruction

This variant treats all research which involves neither teaching faculty nor students as being the only type of research which is not conducted entirely in the support of education. On the rationale that all other research contributes only to education, all costs of such research are considered (support) costs of instruction. In terms of the input/output framework, Alternative 4 may be illustrated as in Figure 7-3 on page 220.

Figure 7-3

USE PROPORTIONS -- Alternative 4

	Graduate Instruction	Undergraduate Instruction	Instructional Services	Departmental Research	Organized Research	Departmental Administration	Final Output
1. Graduate Instruction							100%
2. Undergraduate Instruction							100%
3. Instructional Services	100%						
4. Departmental Research	G%	(1-G)%					
5. Organized Research	$G \cdot (1-P)$	$(1-G) \cdot (1-P)$					P
6. Departmental Administration	(%)	(%)	(%)	(%)			
Direct Costs	D_1	D_2	D_3	D_4	D_5	D_6	
Indirect Costs	I_1	I_2	I_3	I_4	I_5	I_6	
Total Primary Activity Costs	C_1	C_2	C_3	C_4	C_5	C_6	

The first three activities and Departmental Administration would be handled as shown in Alternative 2. Departmental Research, which involves teaching faculty, is considered to produce solely inputs into the instructional program. Therefore, G per cent is registered in the column under Graduate Instruction for Departmental Research and 1-G per cent for Undergraduate Instruction. Organized Research is broken up according to the test mentioned above. That is, after subtraction of non-faculty, non-student research, the remainder is divided G per cent, 1-G per cent between Graduate and Undergraduate Instruction.

Cost allocation which would be dictated by this pattern of use is as follows: First, allocate all Departmental Administration to the other programs. Second, allocate all Departmental Research costs, C_4, to Graduate and Undergraduate Instruction. Third, determine the total activity costs of all Organized Research projects, C_5. Fourth, determine the total costs of all projects in which neither teaching faculty nor students are involved. Denote this amount c_5. Then the proportion of Organized Research outputs used by clients other than currently-enrolled graduate students at the institution is estimated by P where $P = \frac{c_5}{C_5}$. The proportion of use of Organized Research activity used solely by currently-enrolled students, and thus the proportion of costs of the Organized Research activity which should be attributable to the Instructional activity is (I-P).

Alternative 4 has the virtue of simplicity, but it ignores a very important point. It assumes that neither Departmental Research nor the proportion of Organized Research which involves teaching faculty or students has <u>any</u> social value beyond that of support for the graduate instructional function. Miller has provided one rationale for using this alternative in the statement that "an organization should have only one primary mission."[26] As another reason for its use, Miller has observed:

> . . . it is usually considered easier to convince the legislature of the necessity to support teaching than of the necessity to support research or public service.[27]

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[26] Miller [203], p. 100.

[27] _Ibid_.

However, to the extent that such research does have non-instructional value, the procedure will result in overstatement of Instructional costs and corresponding understatement of Research output costs.

Appendix 7-A

EXAMPLES OF ALTERNATIVES IN THE ALLOCATION OF RESEARCH COSTS

The following examples are numerical illustrations of the alternatives described in the text for allocating research costs. In all of these examples, the following assumptions are made:

1. Total primary activity costs (that is, the sum of direct and previously allocated indirect costs for the primary activities) are as follows:[28]
   a. For Graduate Instruction, $25 million.
   b. For Undergraduate Instruction, $15 million.
   c. For Instructional Services, $5 million.
   d. For Departmental Research, $15 million.
   e. For Organized and Sponsored Research, $50 million.
   f. For Departmental Administration, $7.5 million.
2. All activities which contribute to instruction contribute 80 per cent to Graduate Instruction and 20 per cent to Undergraduate Instruction. These proportions were used for illustrative purposes in one major cost study and are used here on the same basis.[29]

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[28] These numbers are roughly similar in volume and proportion to expenditures at a major public institution of higher education.

[29] Hull and McWhirter [160], acknowledge that these proportions are arbitrary but point out that evidence concerning the relationship between research and undergraduate training outputs is scanty:

> Our experience leads us to believe that there is some carry-over of research benefits into the undergraduate program, although it is not possible to determine accurately exactly how much. (p. 17)

The only evidence on this point appears to be inconclusive. Blumberg and Wing in [34], p. 10, found that the size of medical undergraduate programs was not highly correlated with sponsored research expenditures.

3. Departmental Administration costs are allocated to the other activities in the following manner:
   a. \$2 million to Graduate Instruction.
   b. \$2 million to Undergraduate Instruction.
   c. \$1 million to Instructional Services.
   d. \$2 million to Departmental Research.
   e. \$.5 million to Organized and Sponsored Research.

<u>Alternative 1</u>

Allocations for this alternative are shown in Figure 7-4 on page 225. Steps are:

1. The \$7.5 million costs of Departmental Administration is allocated as described above.
2. The Instructional Services costs are allocated 80 per cent to Graduate Instruction and 20 per cent to Undergraduate Instruction.
3. This alternative involves the determination of proportions for allocating research costs on a more or less subjective basis. Probably the least subjective, although not necessarily the least arbitrary, technique applied in this variant was used by Irene Butter.[30] Instead of asking faculty to estimate proportions in which outputs of their activities were used by clients of the Instructional program and outside clients of the Research program, Butter used the ratio of faculty time spent on thesis supervision to faculty time spent on organized and sponsored research in order to distribute some research costs to the instructional activities. The proportions she arrived at averaged 23 per cent. Butter used this ratio only for Organized and Sponsored Research, but the costs allocated to Instruction were allocated entirely to Graduate Instruction. Also, Butter allocated 100 per cent of Departmental Research costs to Graduate Instruction. The example on the following page considers two possibilities: In Case A, Butter's approach

[30] Butter [53], p. 23.

Figure 7-4

ALLOCATION OF RESEARCH COSTS: ALTERNATIVE 1

	Graduate Instruction	Undergraduate Instruction	Instructional Service	Departmental Research	Organized & Sponsored Research	Departmental Administration	Clients (Case A)	Clients (Case B)
Graduate Instruction							$60.415	$ 54.69
Undergraduate Instruction							$ 18.20	$23.925
Instructional Services	4.8	1.2						
Departmental Research	17.0							
Organized and Sponsored Rsrch	11.615						$38.885	$38.885
Departmental Administration	2	2	1	2	.5			
Total Primary Activity Costs ($ Million)	$25	$15	$5	$15	$50	$7.5	$117.50	$117.50

is used. In Case B the same approach is used, however, with the 80 per cent/20 per cent breakdown of costs between Graduate and Undergraduate Instruction.

4. In Case A, $17 million, or the entire cost of Departmental Research, is allocated to Graduate Instruction, and 23 per cent of $50.1 million, or $11.615 million, is allocated to Graduate Instruction from Organized and Sponsored Research costs. The result is the following breakdown of costs for Graduate Instruction, Undergraduate Instruction, and Organized and Sponsored Research: $60.415 million, $18.2 million, and $38.885 million, respectively.
5. Case B makes the same computations but for purposes of comparison uses the previous ratio of 80 per cent allocation to Graduate Instruction and 20 per cent allocation to Undergraduate Instruction. The results for Graduate Instruction, Undergraduate Instruction, and Organized and Sponsored Research were $54.69 million, $23.425 million, and $38.885 million, respectively.

Alternative 2

Alternative 2 proceeds in a manner basically similar to that of Alternative 1 with the exception that the Departmental and Organized and Sponsored Research activities are lumped together, as shown in Figure 7-5 on the following page. Allocations are as follows:

1. The $7.5 million cost of Departmental Administration is allocated as before.
2. Organized and Sponsored Research and Departmental Research activities are considered as one activity and their costs aggregated together. The sum of previously allocated overhead and direct costs, as well as the costs allocated from Departmental Administration for the aggregation of these two activities is $67.5 million. From this amount is subtracted all grant and contract revenue for research purposes. Suppose that this revenue is equal to $50 million. This amount is then entered in the "Final Output" column and the remainder of

Figure 7-5

ALLOCATION OF RESEARCH COSTS: ALTERNATIVE 2

	Graduate Instruction	Undergraduate Instruction	Instructional Services	Departmental Research	Organized and Sponsored Research	Departmental Administration	Final Output
Graduate Instruction							$45.80
Undergraduate Instruction							$21.70
Instructional Services	4.8	1.2					
Departmental Research Organized and Sponsored Rsrch	14.0	3.5					$50.00
Departmental Administration	2	2	1	2.5			
Total Primary Activity Costs ($ Million)	$25	$15	$5	$65		$7.5	$117.50

all research activity costs is allocated to Instruction, again in the proportions 80 per cent to Graduate and 20 per cent to Undergraduate Instruction.

3. Instructional Services costs are allocated as before.
4. The total cost of outputs of the Graduate Instruction activities is therefore the sum of all costs just allocated, plus the total primary activity costs, or \$45.8 million. Similarly, the total cost of outputs of the undergraduate instructional activities is \$21.7 million.

Alternative 3

The third possibility mentioned in the text differs from the first only in that it approximates the proportions for distributing research costs to Instruction and outside research clients in a different manner, as follows:

1. In Figure 7-6 on page 229, it is evident that Departmental Administration and Instructional Services activity costs have been allocated as before.
2. At this point the purely instructional activity costs, including those allocated from the Departmental Administration and Instructional Service activities, total \$50 million. Assuming that the proportion of research activities which produce purely research outputs can be approximated by that proportion which involves no graduate student or graduate faculty participation, then purely research activity costs amount to \$5.05 million as in Alternative 1. The remaining unallocated costs total \$62.45 million. The approach suggested in the third alternative for allocating these costs is to use the proportions determined by costs of the purely instructional and purely research activities. In other words, $\frac{50}{55.05}$, or 90.8 per cent of the unallocated research costs should be allocated to "Final Outputs" of Research. The result of this allocation would be \$77.035 million to outputs of Graduate Instructional activities, \$29.51 million to outputs of Undergraduate Instruction activities, and \$10.955 million to the final outputs of the Research activities.

Figure 7-6

ALLOCATION OF RESEARCH COSTS: ALTERNATIVE 3

	Graduate Instruction	Undergraduate Instruction	Instructional Services	Departmental Research	Organized and Sponsored Research	Departmental Administration	Final Output
Graduate Instruction							$77.035
Undergraduate Instruction							$29.51
Instructional Services	4.8	1.2					
Departmental Research Organized and Sponsored Rsrch	45.235	11.31					$10.955
Departmental Administration	2	2	1	2	.5		
Total Primary Activity Costs ($ Million)	$50	$15	$5	$15	$50	$7.5	$117.50

Alternative 4

This alternative is illustrated in Figure 7-7 on the following page. Allocations are as follows:

1. The $7.5 million cost of Departmental Administration is allocated as described above.
2. All Organized and Sponsored Research projects are examined to determine those which involve neither graduate students nor graduate faculty. The costs of these projects are then separated from the $50 million total primary activity costs of Organized and Sponsored Research. Suppose that these costs equal $5 million. Then the proportion for allocation of Organized and Sponsored Research costs to clients is $\frac{5}{50}$ or $\frac{1}{10}$, which is multiplied times the costs of Organized and Sponsored Research after allocation of Departmental Administration. The remaining amount, $45.45 million, is allocated to Instruction. This amount is broken up between Graduate and Undergraduate Instruction in the ratio of 4 to 1 as assumed above. Therefore, $9.09 million is allocated to Undergraduate Instruction and $36.36 million is allocated to Graduate Instruction.
3. All of Departmental Research, which includes the total primary activity cost and the portion allocated from Departmental Administration is allocated to Instruction. Therefore, using the same proportions, $3.4 million is allocated to Undergraduate Instruction and $13.6 million to Graduate Instruction.
4. Instructional Services are allocated entirely to Instruction, adding $1.2 million to Undergraduate Instruction and $4.8 million to Graduate Instruction.
5. The total cost of outputs of the Graduate Instruction activities is therefore the sum of all costs just allocated, plus the total primary activity costs, or $81.76 million. The total cost of outputs of the Undergraduate Instruction program is then $30.69 million. In order to check the computations, it should be noted that the sum of the dollar figures entered in the column under "Final Outputs" is equal to the sum of the total primary activity costs, i.e., $117.5 million.

Figure 7-7

ALLOCATION OF RESEARCH COSTS: ALTERNATIVE 4

	Graduate Instruction	Undergraduate Instruction	Instructional Services	Departmental Research	Organized and Sponsored Research	Departmental Administration	Final Output
Graduate Instruction							$ 81.76
Undergraduate Instruction							$ 30.69
Instructional Services	4.80	1.20					
Departmental Research	13.60	3.40					
Organized and Sponsored Rsrch	36.36	9.09					$ 5.05
Departmental Administration	2	2	1	2	.5		
Total Primary Activity Costs ($ Million)	$25	$15	$5	$15	$50	$7.5	$117.50

Summary of Four Alternatives

The simple examples just described show that using each alternative to allocate exactly the same costs produces very different results. These results are summarized in Figure 7-8 on page 233. In fact, the alternatives result in declining proportions of costs allocated to Research or, alternatively, increasing costs allocated to Instruction. Alternatives 4 and 2 form the limits of the scale. Alternative 4, which requires allocating all research costs for projects involving graduate faculty and graduate students to Instruction, gives the lowest research cost and the highest graduate instruction cost. Alternative 2, which has been described as the source of funds approach since it allocates only the unrecovered costs of research activities to Instruction, gives the highest research cost and the lowest graduate instruction cost. Alternatives 1 and 3 lie in between the other two. Alternative 3, which involves the creation of synthetic "use proportions" to distribute costs of activities which result in joint outputs, is much closer to Alternative 4 and results in the second-highest instructional costs and the second-lowest research costs. Alternative 1, which might be described as the faculty activity analysis approach, is much closer to Alternative 2 in results. It should be pointed out, however, that the proportions used to illustrate Alternative 1 are based on one study, now over four years old, and for this reason the ranking of results shown on page 233 should not be considered to have general validity.

Figure 7-8

ALLOCATION OF RESEARCH COSTS: SUMMARY OF RESULTS

	Alternative 1		Alter-native	Alter-native	Alter-native
	Case A	Case B	2	3	4
Graduate Instruction	60.415	54.925	45.80	77.035	81.76
Undergraduate Instruction	18.20	23.925	21.70	29.51	30.69
Organized and Sponsored Research	38.885	38.885	50.00	10.955	5.05

CHAPTER 8

PARTIAL EVIDENCE ON THE COSTS OF GRADUATE EDUCATION

Introduction

From previous chapters it is evident that there are many dimensions to the costs of graduate education, whether attention is centered upon total social costs, including opportunity costs, or focused more narrowly upon institutionally-related costs. As a result the problems of measuring these costs, even in the limited sense of institutionally-related costs, are not few. The major difficulties can be briefly summarized as follows:

1. The outputs of graduate and other higher education and the benefits of these outputs are not easily specified, much less measured in quantifiable terms.
2. The numerous dimensions of benefit for each output are not capable of being valued with a meaningful "price" reflecting true value to society. As a consequence, even with some available measures of output, comparison or aggregation of these in terms of value or some meaningful proxy is impossible.
3. Inputs are also not easily separated along lines of activities using them. While this is especially true with respect to the measurement of academic labor, it also holds for capital services and the non-academic inputs used in institutional support activities.
4. While most non-academic labor inputs may be valued on the basis of market determination, the real value of another major input, capital services, is not so easily identified in the meaningful sense of full opportunity costs.
5. The processes by which outputs are derived from inputs, or the "production functions," are unknown for higher education or at

least do not presently lend themselves to expression in terms of both inputs and outputs. Even with some measures and values of outputs and inputs, therefore, attributing particular costs to particular benefits on either an incremental or average basis, is not straightforward.

Under these conditions it is not surprising that the amount of cost data presently available for meaningful comparisons across institutions is very small. To be sure, many studies have been undertaken to attempt to measure institutional costs. For the most part these have been "unit cost" studies and many of these do result in cost "estimates." However, given that so many of the above dimensions are as yet unresolved, the variations in cost studies are many indeed. This makes comparison of presently available cost figures very difficult. Cost studies which have been performed have relied upon different assumptions according to the purposes for which each was intended and are really valid only in light of these purposes. No two cost studies are consistent in all dimensions and estimates calculated using different methodologies, different proxy measures, different time periods and having different purposes cannot be directly compared. Cost information truly designed and relevant for comparison purposes across different educational programs and institutions must await the establishment of consistent definitions and guidelines for measurement of costs and be accompanied by some attention to the similarities and dissimilarities of the outputs or activities being compared. Current efforts of the National Center for Higher Education Management Systems at the Western Interstate Commission for Higher Education (WICHE) should help advance the "state of the art" in this regard.

With the present state of the art, about all that is possible is an arraying of several direct cost estimates in an aggregated fashion which will convey some idea of the wide range over which the costs of graduate education may vary and a few statistical analyses to attempt to identify the major factors influencing this variation. This chapter is divided as follows: The first section discusses the general characteristics of the data employed; the second section presents cost estimates under one definition of "direct" instructional costs for a selected number of disciplines at the Master's and Ph.D. level and discusses problems and possibilities for the calculation of "full" costs; and the third section discusses some statistical analyses of these costs to attempt to identify factors which influence variations in the estimates. The chapter concludes that more detailed institution-by-institution cost comparisons are not useful until consistent definitions, cost allocation methodologies, proxy measures and guidelines for the distribution of costs across the primary functions of the institution have been more fully developed.

The Data

Cost studies have been undertaken for institutions of higher education since the 1920's. As discussed previously, these have varied from salary only studies, to salary plus other "institutionally-related" direct costs, to indirect cost allocation studies attempting full costing through the use of various allocation techniques. A great deal of effort was spent in the attempt to collect such cost data. Letters were sent to the graduate deans and financial affairs' officers at over 285 institutions of higher learning, to all state boards of higher education, and to various other potential contributors. Responses were received from nearly 40% of the graduate deans and financial officers, over 40% of the state boards of higher education, and over 30% of the other organizations and individuals to whom letters were sent, and many materials, including lists of suggested references, unpublished reports, manuscripts, and other documents, were contributed. Relatively few of the materials contained actual cost studies, however. Thirty-five studies were received which contained some cost data, in one form or another, concerning graduate education. These studies plus a number of published reports from the National Science Foundation, the National Academy of Sciences, and the Carnegie Commission on Higher Education comprised the total data file.

Considerable time was devoted to studying this data file in detail. Only twenty-six of these studies could be deemed even potential data sources, eliminating those with very highly aggregated data or containing very specialized data elements. In the final analysis only four of the remaining studies contained roughly comparable data at a satisfactory level disaggregation.

Although not every cost study has been reviewed in the course of this research, it is safe to say that no two cost studies are the same. Depending upon the purposes for which cost information is to be used, specificity in one dimension is traded for specificity in another. For example, most cost studies which calculate cost estimates by discipline are salary only or direct instructional cost only studies and do not attempt allocation of support costs. On the other hand, those which do attempt allocation of support costs usually arrive at estimates which are not disaggregated by discipline or level. Often these studies report costs on an all-campus and per student basis only.

For this study it was determined that any cost aggregations and comparisons would be limited to direct instructional costs only. The tremendous divergence in definitions and procedures for the allocation of "indirect" costs such as the costs of college-level administration, university-wide administration, library, plant operation and maintenance, and so on, cause "indirect cost rates" to vary considerably across institutions. Of the cost studies investigated, relatively few undertook a careful analysis of alternative methodologies or allocation parameters and many full cost estimates were derived simply by prorating indirect costs in accordance with direct cost calculations. Very few studies attempted full allocation on a discipline-by-discipline basis, and of those which did, only one presented graduate cost estimates at a level below all-graduate. It was felt that there would be little meaning in simply taking indirect cost rates from a very small number of studies and applying these to the direct cost estimates of other studies in institutions.[1]

It was also determined that only cost estimates on a discipline basis and by two levels of graduate education would contain whatever interesting information could be gleaned from existing cost estimates.

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[1]Estimates of indirect cost rates which were calculated on a grouped discipline and level of graduate education basis may range from as low as 1.3 to as high as 2.7, depending upon discipline and level. This excludes separately budgeted research costs and estimated associated overhead.

The cost analysis discussed here, then, was limited to the relatively few studies which attempted calculation of the costs of graduate education on a discipline basis and by level breakdown between Master's and Doctorate.

The data relied upon came from four studies performed over the last eight years and covering some thirteen institutions. Since the use of cost figures is for purposes other than those for which the studies were originally undertaken, and since considerable manipulation of the data had to be accomplished in order to allow estimates from different studies to be at all comparable, it was agreed that the data would be arrayed and analyzed on a basis guaranteeing the anonymity of the studies and institutions providing them.

The institutions providing the data are quite diverse in nature although all are public institutions of higher education. In terms of the overall size of their graduate programs they range from less than 1,000 students to over 10,000 students enrolled. Not all of the institutions have Ph.D. programs, nor do all offer graduate degrees in all of the disciplines discussed. Some of the institutions involved appeared frequently in both the 1964 and 1969 rankings of graduate departments by the American Council on Education while others seldom or never appeared in these rankings.[2] As discussed further below, an attempt was made through statistical analyses to take into account some of these dimensions to see whether or not such differences appeared to influence graduate cost estimates across institutions and disciplines.

A representative list of disciplines was selected for the cost calculations. These disciplines are shown in Table 8-I on the following page. While not exhaustive they represent a sample suitable for covering the diversity in graduate education in the United States today. Costs were calculated for the "Doctoral level" and the "Master's level" for each discipline. These designations are not precise, since it was impossible to ensure consistency in the meaning of "level" across the institutions involved. The level designations "Doctoral" and "Master's" are meant to imply level of student being taught. However, it was not possible to control ex post

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[2]See Cartter [62], and Roose and Andersen [251].

Table 8-I

DISCIPLINES INVESTIGATED

<u>Biological Sciences</u>	<u>Letters</u>
Botany	English
Zoology	Philosophy
<u>Business & Management</u>	<u>Mathematics</u>
Business Administration	
	<u>Physical Sciences</u>
<u>Engineering</u>	Astronomy
Chemical Engineering	Chemistry
Electrical Engineering	Geology
Mechanical Engineering	Physics
<u>Foreign Languages</u>	<u>Psychology</u>
Romance Languages	
German Languages	<u>Social Sciences</u>
Classics	Anthropology
	Economics
	Geography
	History
	Sociology

the manner in which course "level" was translated into "level" of student in the various studies. The cost estimates utilized are, nevertheless, intended to distinguish between costs associated with study leading to the Master's Degree from costs associated with study beyond the Master's Degree leading to the Doctorate.

Some adjustments were needed to account for major discrepancies in the cost studies used. A computer program was written to make these adjustments, using as inputs actual data from the cost studies and certain adjustment parameters. It was decided to use full-time equivalent student (FTE) as the "unit" basis for comparison. Since some studies presented figures in terms of quarter student credit hours, or semester student credit hours, an adjustment to FTE was necessary. This was done by defining an FTE student as being equal to 30 quarter student credit hours over the academic year, or 20 semester student credit hours over the academic year.[3] The first step in the adjustment program, then, was to apply these factors to those cost figures expressed either in terms of quarter or semester student credit hours.

The period of time in which each study was conducted ranged over eight years, and an attempt was made to adjust all estimates to "1970 dollars." To accomplish this a price index was applied to the cost estimates for years other than 1970.[4]

These adjustments were necessary to eliminate the obvious differences in the cost estimates available. After the relevant adjustments to the data, cost estimates and other statistics were calculated.

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[3]There is no universal agreement as to what constitutes a full-time equivalent student. The equivalent factors used here, however, are those perhaps most frequently used. See Bisbey [30]; Florida Cost Study Committee and the Office of the State Board of Control [111]; Michigan Council of State College Presidents [202]; and Texas Commission on Higher Education [292].

[4]The price index employed is annually constructed by the Department of Commerce, Office of Business Economics, National Income Division. It is designed as a price deflator for <u>private</u> higher education. It is based upon a weighted average of wages and salaries in private higher education (.75) and the wholesale price index, less food and farm (.25). Discussions with administrators and planners at major public institutions of higher education suggest that as a deflator this index is also appropriate for public institutions.

Direct Cost Estimates

The figures presented here are for those costs which are commonly termed "direct instructional." These generally include: the portion of total faculty salaries paid to instructors and distributed by level for courses taught in the department; and "departmental overhead" which includes administrative direct salaries in the department, non-academic wages, and all current expenses for supplies, materials, services, travel, and equipment which are directly budgeted to the department. The costs include costs for non-separately budgeted or "departmental" research which are instructional in nature but do not actually produce credit hours (e.g., language laboratories), but they exclude the costs of separately budgeted, "organized," research.

It was impossible to guarantee consistency in the definitions and inclusions or exclusions from the direct instructional costs figures made available. The means by which faculty salaries are calculated (e.g., whether actual or averaged over some particular dimension such as faculty rank) and the portions of salaries and overhead costs separated out as the costs of other major activities such as research and public service, were also not consistently derived. Such weaknesses in the data are in addition to the definitional variations of "Doctoral" and "Master's" level outlined above.

Under the umbrella of these caveats, a sample of derived cost figures is presented for the two levels of graduate education in Tables 8-II and 8-III on pp. 246-249 below. The 22 disciplines investigated are shown in Column 1. Column 2 shows for each discipline the number of cost observations available from the studies investigated, including observations for two different years for some institutions. Column 3 gives an estimate of the total number of programs offered nationally for each discipline. Column 4 gives the lowest cost estimate and the highest cost estimate found within each discipline. In many instances the ranges are very wide implying a lack of precision in the figures. Column 5 presents the median observation of the sample figures available for each discipline. In the cases of an even number of observations, the median was estimated by calculating the average of the two middle observations.

Relying upon these cost figures there is very little which can be conclusively stated. One result which does stand out is that direct costs at both the Master's and Ph.D. level in the areas of Laboratory Sciences and Engineering are consistently higher than those for the Social Sciences, Humanities, Mathematics, and Business Administration. This particular result is consistent with other aggregate data and discussions of the relative costs of particular disciplines found throughout the literature on costs of higher education. Caution must be urged even with respect to this general conclusion, however, in light of the nature of this data.

The problems in proceding from direct instructional cost figures to "full" cost figures have been described in the first seven chapters of this report. As mentioned above, very few studies which investigate costs on a discipline-by-discipline basis attempt allocation of indirect costs. Only one of the studies made available was found to make allocations of indirect costs by discipline and simultaneously by the two levels of graduate education. Based upon the limited information available and excluding the costs of separately budgeted or "organized" research and student financial aid in the form of explicit subsidies, sample ratios of "full" costs to direct instructional costs were found to vary at the graduate level between 1.30 and 1.45 for the biological sciences investigated; between 1.19 and 1.52 for the engineering disciplines; between 1.52 and 2.12 for foreign languages; between 1.20 and 1.63 for the physical sciences; and between 1.36 and 2.30 for the social sciences.

Before meaningful full cost estimates can be calculated for comparative purposes, many conceptual and methodological issues remain to be resolved. These ratios give only a very crude indication of what the relationship might be expected to be between the cost figures presented in Tables 8-II and 8-III and cost estimates which would include allocated portions of the costs of the various academic support and administrative support activities in an institution of higher education. Given the paucity of data in this regard and the fact that the definition of full costs can vary considerably according to the purposes of costing, the time dimension involved, and the methodology and allocation parameters used, ratios should be interpreted with extreme caution.

Analyses of Direct Cost Estimates

The range of the figures investigated for each discipline is so large that the perceived differences in the median cost figures across disciplines may be more apparent than real. To test this possibility and to see if factors such as program size and/or apparent quality might explain some portion of the variance within disciplines, a standard statistical technique,

Table 8-II

SAMPLE DIRECT INSTRUCTIONAL COST RANGES
MASTER'S LEVEL

(1970 Dollars/9 Month FTE Student Year)

1 Discipline	2 No. of Observations Available	3 No. of Programs Nationally[a]	4 Master's Direct Cost Range	5 Master's Direct Cost Range Median	6 Master's Full* Cost Range
Astronomy	8	30	$2215-8965	4464	
Geology	12	120	1715-7105	3897	
Chemical Engrng.	12	118	2056-7126	3600	
Mechanical Engrng.	12	143	1350-6938	3255	
Botany	6	84	2025-3824	2770	
Chemistry	22	299	579-4982	2623	
Electrical Engrng.	12	150	1289-4750	2487	
Physics	20	256	440-4843	2356	
Zoology	6	98	2131-2633	2348	
Classics	4	77	1993-2508	2026	
Philosophy	13	120	564-6187	1854	
Geography	16	101	348-3427	1649	
German Languages	14	111	736-3568	1525	
Romance Languages	8	165	1003-1693	1382	
Anthropology	10	72	627-3197	1243	
English	19	425	552-2456	1191	

*For the few available full cost studies which presented costs by department, the ratio of "full" costs (exclusive of separately budgeted research costs and student financial aid subsidies) to direct costs ranged from 1.20 to 2.30 at the graduate level. See p. 245 for further discussion.

1	2	3	4	5	6
Discipline	No. of Observations Available	No. of Programs Nationally[a]	Master's Direct Cost Range	Master's Direct Cost Range Median	Master's Full* Cost Range
Psychology	20	272	$ 417-7038	1184	
History	16	361	690-1668	979	
Mathematics	22	372	614-5526	969	
Economics	15	194	602-1964	961	
Sociology	15	191	487-1170	857	
Business Admin.	19	262	519-1776	794	

[a]The number of institutions offering Masters' programs in each of the disciplines is estimated by the number of institutions granting degrees in the discipline, as reported in *Earned Degrees Conferred*: 1968-69, Part B - Instructional Data, National Center for Educational Statistics (OE-54013-69 Part B), Washington, D.C.: U.S. Office of Education, 1969. These estimates are understated to the extent that some institutions may offer programs, but did not grant any degrees in the discipline in the 1968-69 period.

Table 8-III

SAMPLE DIRECT INSTRUCTIONAL COST RANGES
DOCTORAL LEVEL

(1970 Dollars/9 Month FTE Student Year)

1 Discipline	2 No. of Observations Available	3 No. of Programs Nationally[a]	4 Doctoral Direct Cost Range	5 Doctoral Direct Cost Range Median	6 Doctoral Full* Cost Range
Astronomy	5	35	$3260-15741	10057	*For the few available full cost studies which presented costs by department, the ratio of "full" costs (exclusive of separately budgeted research costs and student financial aid subsidies) to direct costs ranged from 1.20 to 2.30 at the graduate level. See p. 245 for further discussion.
Physics	9	113	1636-11075	7322	
Geology	8	69	4158-13896	6293	
Chemical Engrng.	7	73	2466-9083	6185	
Botany	6	97	3343-7276	5354	
Zoology	6	95	3198-7180	4080	
Mechanical Engrng.	6	71	2508-6938	4035	
Chemistry	13	125	1896-6424	3805	
Electrical Engrng.	7	78	1651-5600	3707	
Classics	4	41	2988-4588	3686	
Business Admin.	7	57	532-7669	3529	
History	8	91	1233-5078	3075	
Geography	6	34	2224-7702	3067	
Mathematics	11	102	1129-6186	2804	
Economics	8	91	1254-3552	2693	
Anthropology	9	42	1599-3427	2665	

1 Discipline	2 No. of Observations Available	3 No. of Programs Nationally[a]	4 Doctoral Direct Cost Range	5 Doctoral Direct Cost Range Median	6 Doctoral Full* Cost Range
Psychology	10	110	$1066-7596	2583	
Philosophy	8	65	1946-4075	2570	
Romance Languages	9	65	1358-3406	1998	
Sociology	9	73	1599-4909	1970	
English	9	92	1120-3511	1784	
German Languages	9	48	552-1970	1112	

[a]The number of institutions offering doctoral programs in each of the disciplines is taken from Kenneth D. Roose and Charles J. Andersen in *A Rating of Graduate Programs*, Washington, D.C.: American Council on Education, 1970. Criteria for inclusion were: (1) The institution awarded at least 100 doctorates in two or more disciplines in the most recent ten-year period for which national doctorate data were available; and (2) For a given discipline, at least one doctorate was awarded in that discipline in the ten-year period.

Business Administration was not included in the Roose-Andersen survey, and the estimate for that discipline is based on the number of institutions granting doctorates in 1968-69 from the Office of Education, Center for Educational Statistics.

regression analysis, was applied to discern whether any statistically significant results could be drawn from the data. Estimating equations of the general form,

$$Y = a_0 + a_1X_1 + a_2X_2 + \ldots + a_nX_n + e$$

were used. In such regression analysis Y is the "dependent" variable, that is the variable whose variance is to be explained. The variables X_1, $X_2, \ldots, X_n$ are "explanatory" variables representing those factors thought a priori to cause the variance in the dependent variable. The term e is the "residual" representing that portion of Y not explained by the variables $X_1, X_2, \ldots, X_n$. The parameters $a_1, a_2, \ldots a_n$ associated with the explanatory variables are "coefficients" whose estimated magnitude is derived from the analysis. Each coefficient, if found to be statistically significant, gives an indication of the magnitude of the effect which its particular explanatory variable has upon the dependent variable while "holding other factors constant." The intent, then, is to "explain" the variance in Y across disciplines and institutions by the variance in the explanatory variables included in the relationship.[5] Analyses were attempted at both the Master's and Ph.D. levels using direct instructional cost per FTE student across disciplines and institutions as the dependent variable (Y) and employing subsets of the following as explanatory (or independent) variables:

Variable Designation	Definition
X_1	Total graduate enrollment after the first year for the particular discipline and institution.[6]
X_2	X_1^2 (Variable 1 squared)

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[5]In the application of a regression model estimates of the a_j's are derived by forming several mathematical relationships from the above expression. These are then solved simultaneously for the a_j's in such a way as to minimize the "unexplained" variation in Y_i, specifically, minimizing the sum of squared residuals across all observations $\left(\sum_{i=1}^{n} e_i^2\right)$. This particular statistical technique is relatively simple to apply and allows for experimentation with numerous alternative specifications of the relationship between dependent and explanatory variables. For a more thorough description of this kind of analysis and its limitations see Johnston [166] and Draper and Smith [96].

[6]Chandler [68], and Chandler and Hooper [70].

Variable Designation (Cont.)	Definition (Cont.)
X_3	1 if Roose-Andersen ranking of graduate faculty is 3.0 or greater, 0 otherwise.
X_4	1 if Roose-Andersen ranking of graduate faculty is 2.0 or greater, 0 otherwise.
X_5	1 if the discipline is a Biological or Physical Science, 0 otherwise.
X_6	1 if the discipline is in Engineering, 0 otherwise.
X_7	1 if the discipline is from the Letters, 0 otherwise.
X_8	Variable X_1 x Variable X_4
X_9	Variable X_1 x Variable X_5
X_{10}	Variable X_1 x Variable X_6
X_{11}	Variable X_2 x Variable X_4
X_{12}	Variable X_2 x Variable X_5
X_{13}	Variable X_2 x Variable X_6
X_{14}	Variable X_3 x Variable X_4
X_{15}	Variable X_3 x Variable X_5
X_{16}	Variable X_3 x Variable X_6

Variables X_3 through X_7 are termed "dummy" variables which are used to quantify dimensions which cannot be measured accurately or in a continuous fashion. Dummy variables are not included for those disciplines which have a Roose-Andersen rank of graduate faculty less than 2.0, nor are dummy variables included for the disciplines which are from the Social Sciences, or for Mathematics and Psychology. The sample observations with these discipline and graduate rank characteristics form the standard against which the other observations are compared for significant differences. Variables X_8 through X_{16} are "interaction" variables which are included in the attempt to determine if and how the cost effects of enrollment and perceived graduate program vary according to discipline. Variables X_1 and X_2 are interpreted together; assuming either or both are statistically significant, they give an indication of how costs per student are affected by program size. For "U-shaped" cost curves, the coefficients of X_1 would be expected to be negative and the coefficient of X_2 would be expected to be positive. Such a combination would indicate that average costs fall over some range of program size and then beyond some point begin to increase again.[7]

At both the Master's and Ph.D. level several estimating equations incorporating various combinations of the independent variables were tested. The actual regression estimates are presented in the appendix. In general, the lack of precision in the data prevented firm conclusions being drawn from these analyses. The results are summarized below, at the Ph.D. level first.

The analyses consistently showed that at the Ph.D. level, Laboratory Sciences, i.e., Biological and Physical Sciences, have significantly higher costs per FTE than either Letters or Social Sciences. The estimated amount of this difference is not, however, insensitive to the particular estimating equation relied upon and ranges from \$2,500 to \$3,500. The analyses also showed that Engineering disciplines have significantly higher costs than either the Letters or Social Sciences in a range from \$2,000 to \$3,000. No significant difference was found statistically between costs in the Letters and those in the Social Sciences. This is not to say that in fact differences do not exist, but only that differences, if any, were not able to be discerned with the data employed here.

With respect to the effects of program size the results are not very conclusive. A consistent result was that the sign for the coefficient of Variable X_1 was generally negative and that for Variable X_2 generally positive. In some instances the coefficients were significant at a fairly low level of statistical confidence. These results are not inconsistent with the hypothesis that cost curves at the Ph.D. level are "U-shaped." The relative magnitude of the coefficients indicated that unit costs decline for increases in enrollment (after the first year) up to about 150 students. The analyses did not show any statistically discernible differences of the effect of enrollments across disciplines. Again, however, these

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[7] This approach to estimating the effects of graduate program size upon average costs is similar to that employed by Gibson in [120], and Blumberg and Wing [34].

weak statistical results do not in any sense allow firm statements in this regard.

With respect to the perceived quality of the graduate degree program, as indicated by the Roose-Andersen rankings of graduate faculty, the results were also not very definitive. The signs of the coefficients for Variables X_3 and X_4 were usually positive, however, and in a few instances significant at relatively low levels of statistical confidence. These results are, again, not inconsistent with the hypothesis that higher quality programs are relatively more costly per student. They do not offer very strong evidence in this regard, however. The cost effects of quality were, again, not statistically different across disciplines.

In all regressions there was a significant difference between cost estimates according to the particular study from which the data were derived. That is, even after attempting to hold all "other factors" constant, cost estimates from different studies were not consistent. In all probability this is due to the considerations discussed above: the use of different methodologies, different measurement techniques, different definitions of program level (Master's versus Ph.D.), and so on. This result tends to confirm the conclusion that methodological variations diminish greatly the relevance in using current data for direct institution-by-institution cost comparisons, and it emphasizes the need for consistency in cost analyses for comparative purposes.

The regression analyses performed at the Master's level gave similar results. Again, average estimated unit costs for both Laboratory Sciences and Engineering were consistently higher than those for Social Sciences and the Letters. The magnitude of the estimated difference was sensitive to the particular estimating equation used as shown in the appendix. For both the Sciences and Engineering this ranged between $1,500 and $3,000. Given the imprecision of the data and absence of an a priori carefully specified model, more precise statements are not justified. As in the Ph.D., regressions in the Letters were not found, statistically speaking, to have significantly different unit costs from the Social Sciences.

Interpretation of the coefficients attached to Variables X_1 and X_2 is weakened by the general lack of statistical significance of the coefficients across the various estimating equations. Consistent with the results obtained for the Ph.D. regressions, however, the sign of the coefficient for X_1 was always negative and that for X_2 always positive; a result which is not inconsistent with the hypothesis that the cost curves at the Master's level also are "U-shaped." At the Master's level the magnitude of the coefficients also indicates possible declining average costs up to total enrollment (after the first year), of about 150 to 160. One result different from the Ph.D. analyses was that the signs of the coefficients for Variables X_8 and X_9 were consistently negative and in some instances significant, although at low levels of statistical confidence, indicating that both Engineering and Laboratory Sciences may experience a decrease in average costs as size increases beyond 150 enrollments after the first year. Again, the proper interpretation of these results is that they are not inconsistent with such hypotheses, and not that they conclusively support such hypotheses.

With respect to the Roose-Andersen rank of graduate faculty, the coefficients for Variables X_3 and X_4 were not statistically significant in most areas. In those instances where they were, however, the sign was positive, indicating that the hypothesis that unit costs are higher in higher quality programs cannot on this basis be dismissed. As in the Ph.D. regressions, no evidence was found that the cost effect of perceived quality varied according to the particular discipline involved. That is, the coefficients for the dummy variables tying the effect of quality rank to discipline, X_{11} through X_{16}, were always insignificant statistically and appeared to be random in sign.

Consistent again with the above analysis of Ph.D. unit costs, cost estimates did appear to be significantly affected by the particular cost study from which they were derived. This again tends to confirm the conclusion that methodological variations greatly reduce the possibilities of using such cost data to show underlying relationships.

Caution is urged in interpreting these results and in deriving any other conclusions from Tables 8-II and 8-III. Throughout the statistical analyses many of the important coefficients were not significant or barely so, and at no time did the percentage of total variance in unit costs which could be "explained" by the variables investigated ever get as high as 80 per cent and in only a few instances was it above 70 per cent. Coupled with the cost ranges per discipline as shown in Tables 8-II and 8-III, this suggests that there is so much randomness in the data that very conclusive statements are not warranted.

Conclusion

In summary, relying upon the data investigated in the course of the study, there are some indications that economies of scale exist in graduate education and that perceived quality differences in program may influence costs. There is more firm evidence that the direct instructional costs of an FTE student year in the Laboratory Science and Engineering disciplines are higher than in the non-Science disciplines. The analyses do not allow more definitive conclusions with respect to any underlying relationships. Since the statistical results themselves are not based upon a thorough and generally accepted economic model of graduate education and do not contain a high degree of confidence, there is no real basis for concluding that the hypothesized relationships are properly specified or proven. In other words, what appears as mild support for hypotheses of the systematic influence of size, perceived quality of degree program, and discipline orientation upon average costs may be reinforced or refuted by better models and more carefully derived and consistent data. Certainly, a great deal more thorough attention must be given to the construction of higher education cost models and gross inconsistencies in the data must be eliminated before any confidence can be placed in further statistical analyses and before the results from such analyses can be considered as potential input into higher education resource allocation and policy decisions.

Appendix 8-A

EXPLANATION OF REGRESSION ANALYSIS

Several regression analyses were attempted. There were not enough observations within each discipline to allow meaningful regressions separately. For the disciplines of Chemistry, Mathematics, English, and Sociology, separate regressions were attempted at the Ph.D. level, to test the effects of differences in program size and perceived program quality. The results were completely inconclusive; not an unexpected result given the exceedingly small number of degrees of freedom.

To increase the degrees of freedom, "pooled" regressions were run employing "dummy variables" to attempt to account for major differences across discipline groups. The results of the pooled analyses are given in Tables 8-IV and 8-V.

The first column shows the set of observations used in the regression analysis. The regression equations marked 1-X rely upon a sample which includes all available observations. The equations marked 2-X use a sample which is more limited; those observations for which perceived quality of the program in terms of the Roose-Andersen rating of graduate faculty is either _greater_ than 3.0 or _less_ than 2.0. All observations which have a Roose-Andersen ranking greater than 2.0, but less than 3.0 were excluded. This was done to attempt to compare only "extremes" in perceived program quality, with the hope that the effects of quality upon average costs might be more clearly discerned. The next seventeen columns show the coefficient estimates for the variables included in each regression (with the exception of the dummy variables used to designate observations from a particular study). The definitions of the variables are given in Table 8-VI. The numbers which appear in each column are the calculated coefficient estimates and the numbers in the parentheses which appear just below are calculated t-statistics which can be used to indicate the statistical significance, or lack thereof, for each estimate. Given the degrees of freedom involved for the coefficients to be termed "statistically significant" at the .95 level of confidence, the t-statistics must be greater than 2.00. To be significant at a .90 level of confidence, a relatively low level in the statistical sense, the t-statistics must be greater than 1.68. The last three columns of Tables 8-IV and 8-V present certain other characteristics of each regression equation useful for indicating the overall performance of the regression analysis. The "F value" must be interpreted in light of the number of parameters estimated in the regression analysis and the total number of observations, less the number of parameters estimated. It indicates whether or not a regression equation contains enough explanatory power for it to be said that a significant relationship exists between the dependent variables and included independent variables in the "overall" sense. Given the number of variables and sample sizes relied upon here, an F level greater than 2.4 is significant at the .95 level of confidence.

The next column, denoted R^2, indicates what percentage of the total variance in the dependent variable is estimated to have been "explained" by the particular variables included in the regression equation. The R^2's are not directly comparable with each other since they are not adjusted for differences in the number of variables included in each equation or for differences in sample size.

A good discussion of general applications, characteristics and variations of regression analysis can be found in N. R. Draper and H. Smith, *Applied Regression Analysis*.[8] Thorough discussions of the application of regression analysis to economic data and types of problems which arise in interpreting results can be found in J. Johnston, *Econometric Methods*; Arthur S. Goldberger, *Econometric Theory*; and Carl F. Christ, *Econometric Models and Methods*.[9]

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[8]Draper and Smith [96].

[9]Johnston [166], Goldberger [121], and Christ [72].

Table 8-IV

PH.D. UNIT COST REGRESSION EQUATIONS

Sample	Intcpt	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	F Value	R^2	Dgrs of Frdm
1-0	3584	-26.90 (1.60)	.0887 (1.33)	218.8 (.257)	1304 (1.23)	2759 (2.32)	3086 (1.89)	770.3 (.461)	-10.89 (.948)	-83.70 (.045)	6.309 (.567)	1383 (1.02)	1344 (.602)	231.7 (.167)	-85.98 (.052)	-2539 (1.14)	-2244 (1.14)	4.5951	.5770	64
1-1	4105	-18.29 (1.21)	.0610 (.999)	488.2 (.602)	--	2716 (3.00)	1908 (1.57)	-576.8 (.614)	-12.49 (1.15)	-5.051 (.276)	3.223 (2.99)	1517 (1.26)	324.3 (.163)	-308.5 (.234)	--	--	--	5.6999	.5570	68
1-2	4095	-13.57 (.930)	.0455 (.756)	--	--	3391 (4.00)	2059 (1.84)	-596.6 (.696)	-7.325 (.739)	-2.529 (.181)	2.179 (.221)	--	--	--	--	--	--	7.1737	.5229	72
1-3	3799	-25.51 (1.58)	.0811 (1.26)	750.1 (1.39)	707.6 (.924)	3096 (3.64)	1861 (1.68)	-953.4 (1.09)	-5.811 (.591)	-2.655 (.191)	3.429 (.350)	--	--	--	--	--	--	6.5213	.5477	70
1-4	4057	-19.56 (1.32)	.0591 (.986)	892.5 (1.73)	--	3151 (3.72)	1932 (1.75)	-800.7 (.937)	-6.592 (.674)	-4.048 (.294)	2.723 (.279)	--	--	--	--	--	--	7.0080	.5422	71
1-5	3716	-23.45 (1.45)	.0801 (1.23)	--	1013 (1.37)	3258 (3.85)	1929 (1.73)	-861.6 (.986)	-6.039 (.611)	-.8818 (.063)	3.314 (.336)	--	--	--	--	--	--	6.8130	.5352	71
1-6	4327	-18.61 (1.58)	.0624 (1.15)	--	--	2922 (5.52)	1883 (2.73)	-543.1 (.899)	--	--	--	--	--	--	--	--	--	10.0559	.5175	75
1-7	3970	-29.98 (2.26)	.0982 (1.69)	750.6 (1.42)	727.4 (.973)	2727 (5.11)	1687 (2.44)	-822.4 (1.34)	--	--	--	--	--	--	--	--	--	8.6775	.5431	73
1-8	4289	-24.77 (2.05)	.0775 (1.43)	895.9 (1.77)	--	2727 (5.12)	1667 (2.42)	-717.6 (1.19)	--	--	--	--	--	--	--	--	--	9.5433	.5372	74
1-9	3867	-27.39 (2.07)	.0951 (1.62)	--	1029 (1.43)	2877 (5.47)	1862 (2.72)	-731.4 (1.19)	--	--	--	--	--	--	--	--	--	9.2872	.5304	74
2-0	3589	-25.46 (1.04)	.0676 (.963)	1495 (1.01)	--	2856 (2.08)	3077 (1.66)	776.4 (.412)	-16.07 (1.11)	-1.668 (.076)	6.889 (.515)	--	--	--	1664 (.896)	-1047 (.388)	-1971 (.840)	3.9627	.5802	43
2-4	3585	-26.04 (1.09)	.0898 (.993)	1573 (1.48)	--	3667 (3.24)	2634 (1.76)	-655.7 (.533)	-9.455 (.767)	-7.263 (.418)	3.243 (.274)	--	--	--	--	--	--	4.7622	.5540	46
2-5	3847	-37.90 (1.93)	.1320 (1.60)	1902 (1.51)	--	2526 (1.92)	2897 (1.60)	648.3 (.349)	--	--	--	--	--	--	662.9 (.422)	-953.9 (.452)	-1496 (.716)	4.8108	.5565	46
2-6	3936	-36.67 (1.94)	.1274 (1.61)	1721 (1.70)	--	3036 (4.28)	2165 (2.44)	-553.6 (.637)	--	--	--	--	--	--	--	--	--	6.5020	.5443	49

Table 8-V

MASTERS UNIT COST REGRESSION EQUATIONS

Sample	Intcpt	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	F Value	R^2	Dgrs of Frdm
1-0	1763	-16.67 (1.98)	.0589 (1.27)	-260.1 (.613)	592.7 (1.12)	1886 (3.17)	1568 (1.92)	1339 (1.61)	-17.02 (2.97)	-1.687 (.180)	-.2732 (.049)	1463 (2.17)	-3097 (2.77)	-138.4 (.199)	126.2 (.154)	3324 (2.98)	-1122 (1.14)	9.5688	.7396	64
1-1	1972	-11.84 (1.42)	.0422 (1.25)	-142.2 (.317)	--	1954 (3.89)	3276 (4.87)	656.2 (1.26)	-17.60 (2.92)	-2.069 (.204)	-1.709 (.286)	1589 (2.38)	-1468 (1.33)	-403.9 (.554)	--	--	--	8.9744	.6644	68
1-2	2027	-13.78 (1.63)	.0476 (1.36)	--	--	2449 (5.00)	2865 (4.42)	442.3 (.891)	-11.15 (1.94)	-12.04 (1.49)	-2.788 (.488)	--	--	--	--	--	--	10.0392	.6053	72
1-3	1631	-23.62 (2.57)	.0827 (2.25)	-88.15 (.287)	1069 (2.45)	2332 (4.82)	2740 (4.33)	182.6 (.368)	-9.865 (1.76)	-10.15 (1.28)	-1.644 (.295)	--	--	--	--	--	--	9.4644	.6374	70
1-4	2022	-14.63 (1.68)	.0495 (1.40)	126.9 (.417)	--	2415 (4.83)	2847 (4.36)	413.2 (.820)	-11.05 (1.91)	-12.25 (1.51)	-2.711 (.471)	--	--	--	--	--	--	9.1115	.6063	71
1-5	1641	-23.86 (2.62)	.0828 (2.27)	--	1033 (2.47)	2313 (4.85)	2732 (4.35)	171.9 (.349)	-9.839 (1.77)	-10.36 (1.32)	-1.630 (.294)	--	--	--	--	--	--	10.3804	.6369	71
1-6	2570	-24.07 (3.45)	.0747 (2.32)	--	--	1705 (5.43)	2077 (5.08)	152.1 (.424)	--	--	--	--	--	--	--	--	--	12.9356	.5798	75
1-7	2059	-33.19 (4.30)	.0110 (3.24)	-104.5 (.340)	1153 (2.65)	1677 (5.40)	2078 (5.17)	-38.57 (.108)	--	--	--	--	--	--	--	--	--	11.7865	.6175	73
1-8	2564	-24.94 (3.40)	.0769 (2.34)	125.9 (.411)	--	1678 (5.20)	2046 (4.90)	127.6 (.349)	--	--	--	--	--	--	--	--	--	11.3697	.5808	74
1-9	2073	-33.55 (4.42)	.0110 (3.27)	--	1111 (2.68)	1657 (5.47)	2054 (5.22)	-51.24 (.145)	--	--	--	--	--	--	--	--	--	13.2415	.6169	74
2-0	1798	-11.45 (.965)	.0440 (1.00)	-20.03 (.028)	--	2057 (3.11)	1513 (1.69)	1334 (1.47)	-21.34 (3.04)	-4.070 (.382)	-1.319 (.204)	--	--	--	1809 (2.02)	495.3 (.380)	-1082 (.955)	5.8814	.6723	43
2-4	1651	-13.98 (1.15)	.0476 (1.04)	471.8 (.872)	--	2867 (5.00)	1676 (2.20)	384.4 (.616)	-14.01 (2.24)	-1.884 (.214)	-2.410 (.401)	--	--	--	--	--	--	6.1245	.6150	46
2-5	2168	-29.03 (2.81)	.0933 (2.15)	749.0 (1.13)	--	1594 (2.30)	1242 (1.30)	1093 (1.12)	--	--	--	--	--	--	414.6 (.502)	405.4 (.365)	-1246 (1.13)	5.4885	.5888	46
2-6	2091	-26.63 (2.65)	.0834 (1.98)	7.308 (1.36)	--	1904 (5.04)	1553 (3.29)	78.57 (.170)	--	--	--	--	--	--	--	--	--	7.1619	.5681	49

Table 8-VI

DEFINITION OF EXPLANATORY VARIABLES

Variable Designation	Definition
X_1	Total graduate enrollment after the first year for the particular discipline and institution.*
X_2	X_1^2 (Variable 1 squared)
X_3	1 if Roose-Andersen ranking of graduate faculty is 3.0 or greater, 0 otherwise.
X_4	1 if Roose-Andersen ranking of graduate faculty is 2.0 or greater, 0 otherwise.
X_5	1 if the discipline is a Biological or Physical Science, 0 otherwise.
X_6	1 if the discipline is in Engineering, 0 otherwise.
X_7	1 if the discipline is from the Letters, 0 otherwise
X_8	Variable X_1 x Variable X_4
X_9	Variable X_1 x Variable X_5
X_{10}	Variable X_1 x Variable X_6
X_{11}	Variable X_2 x Variable X_4
X_{12}	Variable X_2 x Variable X_5

*Chandler [68], and Chandler and Hooper [70].

Variable Designation	Definition
X_{13}	Variable X_2 x Variable X_6
X_{14}	Variable X_3 x Variable X_4
X_{15}	Variable X_3 x Variable X_5
X_{16}	Variable X_3 x Variable X_6

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